

Banking and Securitization

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Abstract

We present a monitoring-based model of banking in which banks can fund their activities with debt, equity, loan sales, and asset securitization. Our results show that banks that have the opportunity to fund themselves via securitization, favor securitization over loan sales. When banks fund themselves with securitization, they have higher profitability, and, depending on the securitization method, higher leverage and lower risk of bank insolvency. We predict that banks with high franchise value will favor securitization methods that reduce bank insolvency, and empirically test this prediction of our theory. Our preliminary evidence is supportive of the theory that securitization reduces risk and improves bank profitability.

Keywords: Banking, Securitization, Loan Sales

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1 Introduction

Loan sales and non-mortgage asset securitizations have been an important part of banking practice since the early 1990s. U.S. secondary loan market volume reached US\$154.8 billion in 2004 from a mere US\$8.0 billion traded in 1991, a compound annual growth rate of 26 percent. In addition, The asset backed securities were reported at \$US2.2 trillion in the first quarter of 2007 (SIFMA). The global total issuance of CDOs (collateralized debt obligations) alone reached US\$550 billion by the end of 2006 (SIFMA).

Although loan sales and securitization activities have grown on global basis, based on FR Y9-C data, the number of U.S. bank holding companies (BHCs) that engage in these activities is small. For example, less than 20% (6%) of BHCs sell (securitize) 1-4 Family Residential Mortgage loans, which are the most commonly sold or securitized asset class (Table 1). Though the number of BHCs that are sellers/securitizers is small, the importance of these activities is better measured by the size of the banks that engage in these activities. By this measure sellers and securitizers are a very significant part of the banking sector. For example, BHCs that are Mortgage sellers and securitizers account for over 37% and 67% of all U.S. BHC assets (Table 2).¹

Given the growth of the markets for loan sales and securitization, it is important to understand how these activities affect the health of the banking sector. In this paper, we help to address this question by theoretically modeling loans sales and asset securitizations within the same framework. We use our model to analyze how asset sales and loan securitizations affect banks' funding costs, leverage, risk profile, and solvency.

When banks fund themselves with debt and equity, they face a tradeoff between the tax disadvantages of equity financing and the financial distress costs that are associated with debt financing. Loan sales and securitization provide alternative channels for financing. However, the extent to which these channels can be utilized are limited by moral hazard considerations. In particular, our model focuses on the role that banks play in monitoring the borrowers that they lend to. Because banks will not monitor assets in which they do not have a financial stake, loans that require monitoring can only partially be financed through loan sales, and securitization. How the banks' moral hazard problem interacts with their funding and risk-taking decisions is the subject of most of our analysis.

For our purposes, the main difference between loan sales and asset securitizations is

¹For details on the data, see the appendix.

the insurance that the two provide against adverse macroeconomic outcomes. Loan sales reduce the banks exposure to individual loans, but because loans in our framework can only partially be sold, the loan sales leave the bank vulnerable to adverse tail events. By contrast, securitization can serve as an insurance against bank insolvency in a severe adverse state of the economy. This is sensible since in the standard securitization, the upper tranches are usually sold to the outside investors and the issuing bank usually holds the most subordinated or the equity tranche. The credit loss to the equity tranche is truncated by the level of subordination while losses in the most severe states are absorbed by outside investors that own the upper tranches.

To anticipate our main results, we find that securitization is a risk management tool for the bank, and that banks who utilize securitization have lower tail risk. This allows them to choose more highly leveraged capital structures that avoid the tax distortions of equity finance. We also find that banks prefer to fund their positions with securitization instead of loan sales when it is possible to do so. We suspect that many banks do not engage in securitization because of its high fixed costs. This is consistent with the empirical observation that in the US large banks securitize while small banks do not.

We analyze two types of securitization, collateralized loan obligations (CLO's), and synthetic collateralized loan obligations (SCLO's). Both types of securitization are analyzed in two-period and multi-period settings for a single bank when all of the bank's assets can be sold or securitized, and when some of its assets are informationally opaque and must be held on balance sheet. In a two-period setting, the bank always uses securitization to shed the tail risk of its asset portfolio because it reduces funding costs. But, how securitization affects the bank's insolvency risk depends on its optimal securitization decision and how it finances its assets that are held on balance-sheet. In a two-period setting, our results on solvency are mixed, we find that in some circumstances banks use securitization to reduce or eliminate their insolvency risk, while for other parameterizations insolvency risk increases when securitization is possible.

In the more realistic multi-period setting, securitization reduces funding costs and it also helps the bank to hedge against insolvency in order to preserve its franchise value. Our principal finding in the multi-period setting is that the most profitable forms of securitization lower the bank's insolvency risk, increase the bank's leverage, and increase the bank's profitability when all of its loans can be securitized, or when only a fraction of its loans can be securitized. We test our principal finding empirically by analyzing the relationship between non-securitizing banks balance sheet composition and their risk, profitability, and

leverage, and then use this relationship to evaluate how these figures would be altered for securitizing banks if their assets were moved back on balance sheet. Our analysis confirms a positive role for securitization.

The rest of the paper contains seven sections. The next section provides a brief literature review. Section 3 presents our basic model of the bank, while sections 4 and Section 5 analyze financing with loan sales and securitizations, and sections 6 and 7 present our theoretical and empirical results. A final section concludes.

2 Literature Review

This paper is related to a large literature on asset sales and loan securitizations.² The most closely related strands of the literature concern bank funding and bank risk management. Asset sales are one many ways that banks can use to fund their activities. However, it has long been recognized that banks' ability to fund themselves in this way is limited by the moral hazard problems mentioned in the introduction, as well as by adverse selection problems. Simply put, because banks know more about the loans that they originate than outside investors, loans can only be sold at a reduced price that reflects a lemons discount. Because of the lemon discount, the early academic literature suggested that loan sales should be rare [Boyd and Prescott (1986), Campbell and Kracaw (1980), and Diamond (1984)].

However, in reality, it is common practice for banks to sell loans. Observing this reality, a strand of the banking literature studies how banks fund themselves by selling assets.³ Key theoretical contributions are Gorton and Pennacchi (1995), Gorton and Souleles (2005), and DeMarzo (2005). Gorton and Pennacchi show that the adverse selection and moral hazard problems associated with loan sales can be partially overcome provided that banks maintain a financial interest in the loans through direct ownership, or through implicit loan guarantees with market participants.⁴ Gorton and Souleles (2005) show that a similar approach can also make financing through securitization feasible. DeMarzo exclusively focuses on adverse selection, and uses a signaling model to study informed financial intermediaries ability to raise revenue through loan sales (pass-through securities) or through a securitization that

²The predominant strand studies how pooling and tranching of asset cashflows affects the risk profiles of CDO tranches, and how those tranches are priced (Duffie and Garleanu 2001; Gibson, 2004).

³Greenbaum and Thakor (1987), DeMarzo and Duffie (1999), DeMarzo (2005), Downing, Jaffee, and Wallace (2007)

⁴Some level of loan guarantees can be sustained in a repeated setting when banks share risk with market participants.

involves pooling and tranching. He finds that pooling and tranching the loans cashflows, and then selling the information insensitive upper-tranche to investors dominates loan sales as a means of generating funding. Empirical evidence supports securitizations role in funding, and shows that whether loans be funded through a securitization market influences banks willingness to originate loans [Loutskina (2005), and Loutskina and Strahan (2006)].

A notable absence from the funding-strand of the literature is any consideration of how loan sales and asset securitizations influence the risk profile of the bank. This is largely the subject of a separate literature. The most closely related papers within that literature are Krahnen and Wilde (2006), Franke and Krahnen (2005), and Instefjord (2005). All three papers study the risk characteristics of banks under various assumptions about banks' securitization and reinvestment policies. Krahnen and Wilde, and Franke and Krahnen, show that under a number of securitization and reinvestment scenarios, securitization can increase firms systematic risk exposures, as measured by asset β . The securitizations in their framework are realistic, but their analysis is limited because the banks do not optimize the form of the securitizations, reinvestment policies, or capital structure. Moreover, banks' role as intermediaries is not modeled. Instefjord models an optimizing bank in a dynamic framework, and analyzes how the availability of a credit derivatives market affects bank risk-taking. We analyze similar issues, but our treatments are very different. Instefjord assumes financial innovation affects bank debt spread dynamics through a change of a correlation parameter, and then studies how the correlation change affects bank risk-taking. His treatment does not model pooling and tranching, and it does not model capital structure choice.

Our paper is perhaps most closely related to the framework of Gorton and Souleles. A key aspect of securitization that is highlighted by them and others is that securitization involves the transfer of assets to a bankruptcy remote special purpose vehicle (SPV). This protects the assets from a bankruptcy process and facilitates their use as a method for financing investments and sharing risk.

This paper's theoretical contribution is that we study the funding and risk management aspects of various securitization structures and loan sales together in a single optimization framework that incorporates banks' role as a financial intermediary that monitors. In our model banks optimally choose monitoring levels, capital structure, loan sales, and the structure of the securitization. Our analysis shows these choices are interdependent, and should be modeled together. The strength of our analysis is that they are modeled together. This allows us to present a more comprehensive picture of how banks' ability to securitize and sell loans affects the banks' portfolio choices, risk-profile, and profitability.

3 The Basic Model

3.1 Overview

We present a stylized model of a bank that originates and finances loans and engages in costly monitoring of the loans that it originates. The bank's monitoring activity reduces the loans' default probabilities and increases their value. The value-creation effect of monitoring is the sole source of the bank's profits.

The risk and profitability of the bank also depend on its chosen capital structure, and its other financing choices. Its financing options include equity, debt, and loan sales; as well as asset securitizations that take the form of Synthetic Collateralized Loan Obligations (SCLOs) and Collateralized Loan Obligations (CLOs).⁵ In choosing between debt and equity, the bank trades off the tax disadvantages of equity against the financial distress costs of debt. If the bank instead finances itself through loan sales and securitizations, it faces agency costs due to moral hazard because the bank will not monitor a loan in which it has no financial interest. Knowing this, potential buyers of the loan will not provide a fair price for any loan that is fully sold. Therefore, to incentivize monitoring, the bank has to distort its actions by retaining a stake in the loans that it sells or securitizes.

The next section provides a detailed description of the two-period version of our model and illustrates the main ideas when the bank's loan portfolio can only be financed through equity and loan sales. In the following sections, we expand the financing opportunities to include debt and securitization and examine how the expanded opportunities alter the results.

In section 6, we extend the two-period model to allow for an infinite number of time periods, and then use simulations to study our model's properties in the two-period and infinite-period settings.

⁵For now we abstract from deposits, but plan to incorporate them in future versions.

3.2 Model Details

The Economy

The bank is studied in a partial equilibrium model of the economy. There are two dates: At date 0 (today), the loans are made, and financing is arranged; at date 1, the loans are paid or default; and the proceeds from the bank's activity are distributed to investors. Whether the loans are paid off depend in part on macroeconomic conditions at date 1. These conditions are indexed by a single discretely distributed state variable that has realizations f , and probability distribution function π_f .

The prices of traded assets in the economy are determined by the preferences of a representative investor with discount factor δ and pricing kernel $\xi_f = \delta \frac{U'(C_f)}{U'(C_0)}$, which represents the ratio of the investor's marginal utility of consumption in each future state relative to marginal utility today. Within this framework, the riskless rate r is implicitly defined by:

$$e^{-r} = \sum_f 1 \xi_f \pi_f,$$

Assets' prices can also be represented as the expected discounted value of future cashflows under the risk-neutral probability measure Q , where discounting occurs at the risk-free rate. In all such computations, q_f is given by

$$q_f = \frac{\xi_f \pi_f}{\sum_f \xi_f \pi_f}.$$

3.3 Lending Opportunities

There are two types of entrepreneurs that each have a single project that requires bank financing. The first type each have a single identically distributed transparent project, where transparent means the bank and outsiders have symmetric information about the characteristics of the loan. The second type of entrepreneurs each have an identically distributed opaque project. Some risk characteristics of the opaque loan are learned by the bank after it extends the loan, but the risk characteristics are not learned by other investors or financial intermediaries.

Each loan i requires S dollars of bank financing. The most an entrepreneur is willing

to pay back upon success is ωS dollars, where $\omega > e^r$. The bank has monopoly power and receives X_i dollars per dollar of loan face value where

$$X_i = \begin{cases} \omega & \text{Loan } i \text{ succeeds,} \\ \omega(1 - LGD) & \text{Loan } i \text{ defaults,} \end{cases} \quad (1)$$

where LGD denotes the fraction of loan value lost in default.

Transparent Lending Opportunities

There are N transparent lending opportunities. The probability that a transparent loan defaults depends on the banks monitoring activities. The cost of monitoring each loan is K . The probabilities that the loan will default in state f if the loan is and is not monitored are denoted by $P(f, m)$, and $P(f, n)$, where m and n represent monitoring and no-monitoring. For simplicity, we decompose each default probability into a component γ_f that depends on the macroeconomic state, and into components e_m and e_n that depend on monitoring:

$$P(f, m) = \gamma_f + e_m,$$

$$P(f, n) = \gamma_f + e_n.$$

Monitoring lowers default probabilities, $e_m < e_n$.

V_m and V_n denote the loan's present value per dollar of face value if it is, and is not monitored, respectively. These quantities are given by:

$$V_m = \omega \sum_f [1 - (\gamma_f + e_m) LGD] \pi_f \xi_f \quad (2)$$

$$= e^{-r} \omega \sum_f [1 - (\gamma_f + e_m) LGD] q_f \quad (3)$$

and

$$V_n = \omega \sum_f [1 - (\gamma_f + e_n) LGD] \pi_f \xi_f. \quad (4)$$

$$= e^{-r} \omega \sum_f [1 - (\gamma_f + e_n) LGD] q_f \quad (5)$$

We assume $V_n \leq 1$, which implies that each loan that the bank might make has a non-positive net present value unless the bank monitors the loan. This implies that on a per loan basis, the bank originates loans for a cost of S , then pays an additional cost K for monitoring, and transforms them into loans that have value SV_m . This generates a profit per loan of $S(V_m - 1) - K$. We denote this quantity as VF , the value of the banking firm per loan originated, and assume that it is positive. This is formalized in the following assumption:

Assumption 1 $VF = S(V_m - 1) - K > 0$.

Opaque Lending Opportunities

The bank has the opportunity to make N_O opaque loans, $j = 1, \dots, N_O$. The opaque and transparent loans differ because banks have better information about the systematic component of opaque loans' default probabilities than outsiders do. This is formalized by assuming that the default probability of each opaque loan with and without monitoring is given by:

$$P(f, m) = \beta_j \gamma_f + e_m,$$

$$P(f, n) = \beta_j \gamma_f + e_n,$$

where β_j represents firm j 's default sensitivity to changes in the macroeconomic state. The banks only learn the parameter β_j after they extend the loan and before it can be sold or securitized. Based on outsiders information, β_j is distributed i.i.d. across the loans over the support $[\beta_L, \beta_H]$ with continuous distribution function $G(\beta)$. We assume that the support of β_j is such that $P(f, m)$ and $P(f, n)$ lie between 0 and 1 for all f . The β_j are also distributed independently of the macroeconomic state. For convenience we assume $E(\beta_j) = 1$; this guarantees that if the transparent loans are individually profitable for the bank to originate ex-ante, then the opaque loans will also be profitable ex-ante and vice versa. We also make the simplifying assumption that the distribution function $G(\cdot)$ is strictly increasing, and has no atoms.

The next subsection illustrates the main ideas in the model when financing is only through equity and loan sales. We then move to consider more general financing arrangements.

3.4 A Bank Financed by Equity and Loan Sales

To begin the analysis, we consider the financing of a single transparent loan. The bank requires $S + K$ to both fund and monitor the loan. Without loss of generality we assume that the bank holds θ dollars of face value on its own balance sheet, and for simplicity simultaneously sells $S - \theta$ dollars of face value in the market.⁶ Provided that investors in the market believe the loan will be monitored, the bank sells each dollar of face value at price V_m , raising in total $(S - \theta)V_m$ from loan sales.

Let $FC(\theta)$ denote the bank's residual financing costs per loan, when it holds θ dollars of loan face value on balance sheet and sells the rest. $FC(\theta)$ is given by:

$$\begin{aligned} FC(\theta) &= S + K - (S - \theta)V_m \\ &= S(1 - V_m) + K + \theta V_m \\ &= -VF + \theta V_m \end{aligned} \tag{6}$$

From the above expression, it should be clear that if θ is small enough, the residual funding costs that are required will be negative; in other words no equity funding will be required. To rule out that uninteresting case, we assume that the model's parameters are such that in equilibrium equity holders' financing costs are positive.

Assumption 2 *The model parameters are such that an all-equity financed bank that makes a single loan has positive finance costs FC_E .*

To derive a sufficient condition for funding costs to be positive, we first solve for equilibrium θ . Recall that in any equilibrium with loan sales, monitoring must be incentive compatible (IC) in order to sell the loan at a price of V_m per dollar of face value. IC requires that θ is chosen so that the value of equity holders' assets net of monitoring costs is greater than their value when not monitored:

$$\theta V_m - K \geq \theta V_n.$$

⁶The assumption that the origination and sale of the loan are simultaneous is reasonable since Drucker and Puri (2007) found that over 60% of loans are sold within one month of loan origination and nearly 90% are sold within one year.

Rearrangement produces the incentive constraint:

$$\theta \geq \frac{K}{V_m - V_n} \equiv \theta^*. \quad (7)$$

θ^* denotes the minimum face value of the loan that the bank must retain on balance sheet in order to make monitoring incentive compatible. Because financing costs for equity holders' are increasing in θ , Assumption 2 and Equations (6) and (1) show that a sufficient condition for financing costs to be positive is

$$\begin{aligned} FC_E &= -VF + \theta^*V_m \\ &= S(1 - V_m) + K + \frac{KV_m}{V_m - V_n} \geq 0 \end{aligned} \quad (8)$$

In the all-equity bank with a single loan, equity holders are indifferent over the choice of θ subject to it satisfying the incentive constraint (7). We will make the additional assumption that equity financing is costly. For expositional purposes in the text this is modeled with the assumption that the bank's balance sheet is liquidated at the end of period 1 and distributed to equity holders, and equity holders face a tax on distributions (dividends) that is equal to τ . In the appendix, we provide a more formal treatment of taxes which produces qualitatively similar results.

Given our assumptions on financing costs, equity holders pay the financing costs and obtain an asset that has value $(1 - \tau)\theta V_m$. Therefore, net of financing costs, the value of the bank to the equity holders that contribute the initial cash is given by:

$$\begin{aligned} V_E &= (1 - \tau)\theta V_m - FC_E \\ &= (1 - \tau)\theta V_m - [-VF + \theta V_m] \\ &= VF - \tau\theta V_m \end{aligned} \quad (9)$$

Equity-holders maximize V_E by choosing θ to be as small as possible given the incentive constraint (7). Analogous results hold for N loans.

This establishes that when equity financing is costly, an all-equity and no-debt bank with only transparent loans will fund itself by selling off as much of each transparent loan as possible while maintaining monitoring incentives.

Opaque loans

Let θ_O denote the amount of face value of the opaque loan that the bank chooses to hold on balance sheet. Given our parameterization of default probabilities, if the single loan is opaque, monitoring incentives are unchanged, but the bank's ability to sell loans is reduced because of adverse selection. To illustrate the first of these points, let $V_m(\beta)$ and $V_n(\beta)$ denote the market value of a loan with macro-sensitivity β if it is and is not monitored. Examination of the structure of default probabilities for the loan with and without monitoring, shows that $V_m(\beta) - V_n(\beta)$ is a constant that does not depend on β , and moreover that monitoring is IC if $\theta_O \geq \theta^*$ as in the case with transparent loans.

For simplicity, we only study equilibria in which opaque loans are monitored. To illustrate how opaqueness affects the ability to sell loans, we first consider a competitive pooling equilibrium in the loan sales market when the tax rate on distributions, τ , is equal to zero. In this case, the loan sales market completely collapses due to adverse selection as in Akerlof (1970).⁷ To see why collapse occurs, note that in the competitive pooling equilibrium all opaque loans sell for price P , and P must satisfy the buyer rationality condition $P = E[V_m(\beta_j) | \text{Loan Sale at Price } P]$, and the seller rationality condition that sold loans have β_j such that $V_m(\beta_j) \leq P$. These conditions are only satisfied when $P = V_m(\beta_H)$ and only loans with $\beta_j = \beta_H$ are sold. Since $G(\cdot)$ has no mass points, opaque loan sales occur with probability zero, implying the bank must keep 100 percent of the face value of each opaque loan on its balance sheet. When $\tau > 0$, the bank's equity holders, who are taxed, and potential outside loan purchasers, who are not taxed, have different marginal valuations for the loan. This creates a basis for trade and moderates the adverse selection problem. Nevertheless, adverse selection will typically make it impossible to sell some of the opaque loans in the competitive pooling equilibrium.⁸

In a fully separating equilibrium, the bank may be able to sell some of its loans by

⁷When $\tau = 0$, the bank's equity holders have the same marginal valuation for the loans as potential loan purchasers. Therefore, because of adverse selection, potential loan purchasers will be unwilling to purchase any loan that the bank is willing to sell except at the lowest possible price.

⁸When $\tau > 0$, the equilibrium condition for buyers remains as before, and the bank is willing to sell loans for which $(1 - \tau)V_m(\beta_j) \leq P$. The new equilibrium price satisfies

$$P = E(V_m | P) = \frac{\int_{\beta_P}^{\beta_H} V_m(\beta) dG(\beta)}{1 - G(\beta_P)},$$

and the bank sells all loans for which $\beta_j \in [\beta_P, \beta_H]$ where β_P is the smallest value of β for which the bank is willing to sell the loan given P (i.e. $V_m(\beta_P) = P$). Exactly which loans can be sold depends on $G(\cdot)$ and on the tax rate.

signalling their quality with credit enhancements [Greenbaum and Thakor (1987)], or through the quantity of loans held on balance sheet when doing so is costly [Duffie and DeMarzo (1999), DeMarzo (2005)], as it is in our model when $\tau > 0$. We follow the quantity signalling approach and for simplicity only focus on equilibria where monitoring is incentive compatible. Following DeMarzo (2005), the bank chooses q , the fraction of opaque loans that are sold (where q is equal to $(S - \theta)/S$), to maximize a transformed version of equity holders' value (from equation 9) subject to the constraint that $q < q^*$, where q^* is the maximal value of q that satisfies the IC constraint (7).⁹ Let $q(\beta)$ denote the optimal choice of q given β , and let $P[q(\beta)]$ denote the equilibrium price per dollar of loan face value as a function of q . Relatively straightforward application of results in Duffie and DeMarzo (1999) show that $q(\beta)$ and the price as a function of $q(\beta)$ are given by^{10,11}:

$$P(q(\beta)) = V_m(\beta_H) \left[\frac{q^*}{q(\beta)} \right]^\tau \quad (10)$$

$$\frac{q(\beta)}{q^*} = \left[\frac{V_m(\beta)}{V_m(\beta_H)} \right]^{(-1/\tau)} \quad (11)$$

Equation (11) shows that the percentage of each loan of quality β that can be sold in equilibrium declines with $V_m(\beta_H)$, the quality of the worst possible opaque loan. In the worst possible case, if $V_m(\beta_H) = 0$, then no opaque loans can be sold in the separating equilibrium. In this version of the paper, we assume that the opaque loans in our model satisfy this worst possible case, implying that the adverse selection problem is so severe that the informationally opaque loans must be held on balance sheet.¹² Our assumption is consistent with the fact that many loans are neither sold nor securitized and with empirical evidence that sold loans tend to be less informationally opaque than loans that are not sold

⁹ q is chosen to maximize equity holders' value, $V_E(q)$, which rewritten from equation (9) has form:

$$\begin{aligned} V_E(q) &= \alpha + \Pi(q, V_m(\beta), \tau), \\ \text{where, } \alpha &= (1 - \tau) S V_m(\beta) - S - K, \\ \Pi(q, V_m(\beta), \tau) &= Sq[P(q) - (1 - \tau)V_m(\beta)]. \end{aligned}$$

The signalling equilibrium also requires that optimal $q(\beta)$ is an invertible function of β , and that the market price of the loan is equal to its true value conditional on β : $P(q(\beta)) = V_m(\beta)$. These conditions imply that $q(\beta)$ is a monotone increasing function of β . In addition, incentive compatible monitoring requires that $q \leq q^*$ where $q^* = 1 - \theta^*/S$. These conditions imply $P(q^*) = V_m(\beta_H)$.

¹⁰As noted in DeMarzo(2005), there will be a multiplicity of signalling equilibria which vary based on off the equilibrium path beliefs. The set of equilibria can be reduced via standard refinements.

¹¹The appendix derives a similar separating equilibrium in a more general setting with taxes.

¹² $V_m(\beta_H) = 0$ is an assumption that we make for convenience. To formalize the assumption, would require us to complicate our modeling of LGD since LGD must be equal to 1 for the lowest quality opaque loans in order for $V_m(\beta_H) = 0$.

[Drucker and Puri (2007)].

The next section studies how our results change when the bank is financed with debt and equity.

4 Financing with debt, equity, and loan sales

In this section, the bank finances its $N + N_O$ lending opportunities through debt, equity, and loan sales. Because the transparent opportunities are identical, we assume the bank chooses to hold θ dollars of each transparent loan on balance sheet while selling off the rest. This requires debt and equity holders to cover total financing costs $TFC(\theta)$ given by:

$$TFC(\theta) = N FC(\theta) + N_O FC(S),$$

where FC is the residual financing cost per θ dollars of loan held on balance sheet from equation (6). The bank's choice of leverage is proxied by the parameter α , which is approximately equal to the percentage of $TFC(\theta)$ that is covered by equity. The bank sells debt which promises to pay back $D_1 = (1 - \alpha)TFC(\theta)$ at time 1 if the bank is solvent.

The value of the banks loan portfolio at time 1 is denoted by the random variables $VP(\theta)$, where:

$$VP(\theta) = \sum_{i=1}^N \theta X_i + \sum_{j=1}^{N_O} S X_j. \quad (12)$$

The bank will be solvent at time 1 if the value of it's portfolio exceeds it's required debt payments. Whether the bank is insolvent at time 1 is represented by the indicator function χ_D , which takes the value 1 when the bank becomes insolvent and 0 otherwise:

$$\chi_D = \begin{cases} 0, & \sum_{i=1}^N VP(\theta) \geq D_1 \\ 1, & \sum_{i=1}^N VP(\theta) < D_1 \end{cases}$$

If the bank becomes insolvent, the bank's assets are transferred to debt holders through a bankruptcy process. Because of the costs of bankruptcy, debt holders only recover a fraction $\phi < 1$ of the value of the bank's assets during insolvency.

We assume the bank's debt is priced fairly. This implies, the present value of the debt is given by D , where

$$D = e^{-r} E_q [(1 - \chi_D) D_1 + \chi_D \phi VP(\theta)] \quad (13)$$

When pricing the bank's debt, the above expectation must be taken over the distribution of the opaque loan's macro-economic sensitivities $\beta_j, j = 1, \dots, N_O$. Fortunately, by the law of iterated expectations it suffices to compute these expectations using opaque borrowers expected default probabilities, which correspond to $\beta_j = 1$ for all j .

The debt's spread over the risk free rate is denoted by s_D , where

$$s_D = -\ln(D_1/D) - r \quad (14)$$

The funding costs covered by equity holders at time 0 are given by $E = TFC(\theta) - D$. In addition, after taxes equity holders receive payments $(1 - \tau)[VP(\theta) - D_1]^+$ at time 1. The bank chooses α and θ to maximize V_E , the present value of equity holders' claim on the bank net of the financing costs that are covered by equity holders:

$$V_E = (1 - \tau)e^{-r} E_q [VP(\theta) - D_1]^+ - [TFC(\theta) - D]$$

This maximization is conducted subject to the constraint that monitoring is incentive compatible. Whether the bank will choose to monitor depends on how it would otherwise use the funds that it was supposed to have used for monitoring. For simplicity, we will assume that these funds will instead be invested in risk-free assets. In addition, we invoke the following "large bank" assumption:

Assumption 3 *For sufficiently large N , whether the bank monitors a single loan does not alter the banks probabilities of defaulting on its debt conditional on the macro-economic state variables. Moreover, how the bank invests the money saved by not monitoring does not alter its probabilities of default conditional on the macroeconomic state variables.*

This assumption is reasonable for a large bank that makes many loans. The equity holders only receive the proceeds from monitoring or not monitoring if the bank remains

solvent. Let P_f denote the probability that the bank becomes insolvent conditional on state f .

Under the large bank assumption, if the bank does not monitor a single loan (indexed by i), the expected value of not monitoring to shareholders is given by:

$$(1 - \tau) \sum_f \{ \theta_i \omega [1 - (\gamma_f + e_n) LGD] + K e^r \} (1 - P_f) \pi_f \xi_f,$$

This expression is the expected present value of the loans' cashflows in each state when the loan is not monitored plus the present value of the risk-free investment in each state times the probability that the bank survives in that state.

Similarly, if the bank monitors the loan, the present value of monitoring to shareholders is given by:

$$(1 - \tau) \sum_f \theta_i \omega [1 - (\gamma_f + e_m) LGD] (1 - P_f) \pi_f \xi_f,$$

Note that the two expressions differ in that not monitoring increases the default probability of the loan, and provides the banks investors with an additional asset that has present value K . The incentive constraint with simplification, shows that:

$$\begin{aligned} \theta_i &\geq \frac{K \sum_f (1 - P_f) q_f}{e^{-r} \sum_f \omega (e_n - e_m) LGD (1 - P_f) q_f} \\ &= \frac{K}{e^{-r} \omega (e_n - e_m) LGD} \\ &= \frac{K}{V_m - V_n}. \end{aligned} \tag{15}$$

This constraint turns out to be identical to the constraint on θ when there is only a single loan and it has the convenient property that the constraint does not depend on how the other θ_i were chosen, nor does it depend on the amount of leverage employed by the bank. The constraint will be more complicated if the bank can invest the monitoring costs that are saved, K , in assets other than the riskfree asset. In this case, the constraint will

depend on its other investment possibilities.¹³ For now, we abstract from this possibility to keep the analysis relatively simple.

This inequality leads to the following proposition:

Proposition 1 *If the bank can only invest the proceeds from not monitoring in the riskfree asset, then under assumption 3, the condition $\theta_i \geq \frac{K}{V_m - V_n}$ for all loans i is necessary and sufficient to guarantee that all loans are monitored.*

Proof: *Necessity follows from noting that if there is a single loan for which θ_i is so small that it violates the incentive constraint, then for that loan, equity holders' would benefit from not monitoring. To establish sufficiency, suppose that the condition is satisfied, but there is a fraction of loans that the bank finds it optimal not to monitor. Then, pick one of the loans that the bank chooses not to monitor. Since the holdings of the loan satisfy the inequality constraint, the bank would benefit from monitoring it. This contradicts the assumption that the condition holds but there are loans that it is not optimal to monitor.*

The proposition shows that the banks maximization problem reduces to:

$$\max_{\theta, \alpha} V_E = (1 - \tau)e^{-r} E_q[VP(\theta) - D_1]^+ - [TFC(\theta) - D]$$

subject to the incentive constraint in equation 15. Note that in this maximization, D_1 and D are functions of α and θ .

In the next subsection, to provide intuition, we will solve the bank's maximization problem in the context of a specific example.

¹³If the bank's preferred choice for investing the proceeds from not monitoring is a risky asset with return \tilde{R} , then, under the large bank assumption, incentive compatibility of monitoring requires that the bank's loan holdings satisfy the inequality:

$$\theta_i \geq \frac{K}{V_m - V_n} + \frac{Ke^{-r}Cov_q(\tilde{R}, 1 - P(f))}{(V_m - V_n)E_q(1 - P_f)}$$

This more general inequality is harder to work with, but should also provide necessary and sufficient conditions for monitoring when the money from shirking can be invested in other assets.

4.1 Basic Model Properties without Securitization

At this juncture, it is useful to discuss the properties of the bank when faced with these financing alternatives. To begin, if there are no taxes or financial distress costs ($\tau = 0$ and $\phi = 1$), then a version of the Modigliani-Miller theorem is satisfied, and all choices of α and θ produce the same value for shareholders provided that monitoring is incentive compatible. If $\tau > 0$, then equity capital is expensive. Therefore, for any choice $\alpha > 0$, a higher value of θ increases costs to equity holders, so equity holders would like to choose θ as small as possible conditional on $\alpha > 0$. This means they will choose the smallest θ that satisfies the incentive compatibility constraints. The case $\alpha = 0$ deserves additional discussion. If the bank is free to choose α , then it will choose α equal to 0. Under this case, the owners of the bank finance the bank entirely with debt. This should make equity holders indifferent over the choice of θ conditional on θ satisfying the incentive constraints.

To further narrow the choice of optimal θ and capital structure, it is necessary to impose bankruptcy costs by setting $\phi < 1$. To avoid bankruptcy costs, the bank will optimally choose $\alpha > 0$, and then to minimize financing costs, it will choose the smallest θ that is consistent with the incentive constraints. In other words, it is optimal for the bank to finance with as much loan sales as it can since doing so avoids the tax costs of equity financing and the bankruptcy costs of debt financing. Nevertheless, because the bank has to hold some assets on its balance sheet, it retains a risk of financial distress and insolvency.

We illustrate these ideas in the context of a benchmark numerical example that we will also use to study securitizations. The figures in the example were chosen to illustrate ideas and not for realism. In the example, the representative investor has CRRA utility with a coefficient of relative risk aversion set at 10, and with a discount factor $\delta = 0.99$. There are three possible macro-economic states (see Table 3): State 1 is associated with mild growth, state 2 is associated with a slight slow-down in growth, while state 3 represents a severe slow-down, that is parameterized to be akin to a depression. The macroeconomic component of default probability in the depression, γ_f , is very high; and consumption in the depression state is very low. Therefore the pricing kernel in the depression state, ξ_f , is extremely high, implying that investors especially want to insure against losses in that state. The depression state is assumed to have a low probability, .01; this means that the expected number of years in depression over the next one-hundred years is one year. The presence of the depression state severely affects the risk-neutral probabilities, causing state 1 to be assigned far less risk-neutral probability q_f than its physical probability π_f while the reverse holds for state 3. In the current setting, the one-year real risk-free rate is equal to 1.78 percent.

Table 3: Macroeconomic Parameters

State (f)	γ_f	π_f	ξ_f	q_f	c_f
1	.01	.9	.73	.67	.03
2	.02	.09	.81	.07	.02
3	.2	.01	24.93	.25	-.32

Notes: For each future macroeconomic state f , γ_f is the systematic component of loan default probability, π_f is the probability of the state; ξ_f is the pricing kernel in state f , q_f is the state probability under the equivalent martingale measure, and c_f is the realized rate of consumption growth between period 0 and the future macroeconomic state f .

Table 4: Loan Specific Parameters

Specific Prob Default without monitoring (e_n)	0.03
Specific Prob Default with monitoring (e_m)	0.01
Loan Face Value (S)	100
Monitoring Cost (K)	1
Loss Given Default (LGD)	0.7
Loan Value (per dollar of face) if monitored (V_m)	1.0149
Loan Value (per dollar of face) if not monitored (V_n)	1
Bank Value (per loan)	0.4930
Number of transparent loans	90

The parameters of the loan in the example are provided in Table 4. The face value of each loan is normalized to 100; using this normalization, θ is the percentage of face value retained in the bank's portfolio. The loan-specific probabilities of default with and without monitoring are 1 and 3 percent respectively; and the loss given default (LGD) is 0.7. Under these assumptions, the contribution to bank value per loan, VF , is 0.4930. In our basic benchmark there are $N = 90$ transparent lending opportunities and $N_0 = 0$ opaque opportunities. We will later contrast this with the more realistic case that the bulk of the bank's lending opportunities are opaque. Given our parameterization, in a Modigliani-Miller world $\phi = 1$, $\tau = 0$, and the value of the bank's equity is $(N + N_0) \times VF = 44.37$. With these choices for the model's parameters, incentive compatibility for monitoring requires that $\theta \geq 66.98$.

We illustrate the properties of the model when τ , the tax rate on equity, is equal to 2 percent, and when ϕ , the percentage of bank assets recovered in insolvency, is 97 percent. Under this specification, for any choice of α , Table 6 shows that the value of the bank is decreasing in θ . Therefore, the bank will choose the smallest θ that is incentive compatible

with monitoring. The choice of α trades off the distress costs of bankruptcy with the tax disadvantages of equity. With this choice of model parameters, the bank's approximately optimal choice of α is 0.15, and the bank's probability of default is 6 basis points (Table 7, Panel A), but this low default probability is costly because Table 6 shows that the approximate value of the bank to equity holders is only 22.83, which is less than half its value in the absence of tax and bankruptcy costs. For purposes of contrast, Table 6 can also be used to examine the bank's optimal choices if it can originate opaque and transparent loans, but cannot sell them. In this case, the fraction of financing that is covered by equity is about the same, but the bank's profit declines by over 30 percent.¹⁴

This example illustrates how tax and bankruptcy costs affect the financing choices of the bank when the only financing alternatives are debt, equity, and loan sales. The next section allows for a richer set of financing alternatives by including loan securitization.

5 Securitization

In this section, we allow the bank to also finance its transparent loans through the use of securitization. The important aspect of securitization is that it is a risk management tool that alters the pattern of cashflows received by the bank in ways that are not possible with loan sales, equity, and debt on their own. We allow the banks to consider two types of securitization: Synthetic Collateralized Loan Obligations or SCLOs; and Collateralized Loan Obligations or CLOs. In the case of SCLOs, the bank will optimally retain a portion of the loans that it securitizes on its own balance sheet, but will purchase credit protection on those loans, which is equivalent to selling a part of the credit risk to the market. In a CLO, the bank sells the loans from its balance sheet, but it retains ownership of the equity tranche of the CLO in order to incentivize monitoring. Each securitization method is discussed in further detail below.

SCLO

In the SCLO, the bank holds onto its loans, but it uses securitization to buy protection against the default of some of the assets in its loan portfolio. Partition the bank's loan portfolio into two parts with N_S and $N - N_S$ loans. The N_S loans are part of the synthetic

¹⁴Tables 7, panel A; and Table 6 produce slightly different results for the bank's optimal capital structure and profit in our benchmark case because the maximizations were conducted using different discretizations of the bank's choice set. The results in Table 7 are the more precise of the two.

securitization. Index the loans in the securitization by j , and let θ_j be the face amount of each loan that is securitized (note that the bank does not have to securitize the whole amount of any loan). For simplicity, assume that the θ_j are identical and equal to θ_S . We will assume that in the SCLO the bank buys protection against the possibility that more than ψ of the loans in the securitization default. Let $N_{D,S}$ denote the number of loans in the securitization that default. Then when the SCLO matures, the bank receives payments of $\text{Max}(N_{D,S} - \psi, 0) \omega \theta_S LGD$, which protects the bank fully against all loan defaults beyond the first ψ .

In our two-period setting the bank pays for the credit protection at time 0 in the form of a fee $F(\psi, \theta_S, N_S)$. If the credit-protection is priced fairly, then the amount of the fee is given by:

$$F(\psi, \theta_S) = e^{-r} E_q \omega \theta_S LGD \text{Max}(N_{D,S} - \psi, 0) \quad (16)$$

When the bank buys credit protection, it affects its own incentives to monitor the loans, which in turn will affect the fee that the bank must pay for protection. The bank's incentive to monitor (from the perspective of equity holders) is affected by both θ_s and ψ , since for example if $\psi = 0$ then the bank retains no credit risk and has no incentive to monitor.

To model the incentive constraints, for simplicity we make a "large securitization" assumption. More specifically, we assume the probability that the protection seller must pay does not depend on whether a single loan is monitored. Under this assumption, if the bank chooses not to monitor one of the loans (indexed by i) that is insured in the CLO structure, and if it invests the savings from not monitoring at the riskfree rate, then the expected value of this loan plus the proceeds from not monitoring is given by:

$$\begin{aligned} & (1 - \tau) E \left(\sum_f 1_{\{N_{D,S} \leq \psi\}} (\omega \theta_S [1 - (\gamma_f + e_n) LGD] + K e^r) (1 - P_f | N_{D,S} \leq \psi) \pi_f \xi_f \right) \\ & + (1 - \tau) E \left(\sum_f 1_{\{N_{D,S} > \psi\}} (\omega \theta_S + K e^r) (1 - P_f | N_{D,S} > \psi) \pi_f \xi_f \right), \end{aligned} \quad (17)$$

where $(1 - P_f)$ denotes the probability that the bank remains solvent in state f .

Note that in the above expression, when the number of defaults is greater than ψ , the

cashflows that the bank receives from each additional loan is $\omega\theta_S$ because the synthetic CLO fully insures the bank against all but the first ψ defaults.

If the bank spends the monitoring costs, then the value of the monitored loan to equity holders is given by:

$$\begin{aligned} & (1 - \tau) E \left(\sum_f 1_{\{N_{D,S} \leq \psi\}} (\omega\theta_S [1 - (\gamma_f + e_m) LGD]) (1 - P_f | N_{D,S} \leq \psi) \pi_f \xi_f \right) \\ & + (1 - \tau) E \left(\sum_f 1_{\{N_{D,S} > \psi\}} (\omega\theta_S) (1 - P_f | N_{D,S} > \psi) \pi_f \xi_f \right), \end{aligned} \quad (18)$$

Rearranging the two equations shows that monitoring is incentive compatible if

$$\begin{aligned} \theta_S & \geq \frac{K e^r E \sum_f [1_{\{N_{D,S} \leq \psi\}} (1 - P_f | N_{D,S} \leq \psi) + 1_{\{N_{D,S} > \psi\}} (1 - P_f | N_{D,S} > \psi)] \pi_f \xi_f}{E \sum_f 1_{\{N_{D,S} \leq \psi\}} \omega(e_n - e_m) LGD (1 - P_f | N_{D,S} \leq \psi) \pi_f \xi_f} \\ & = \frac{K E_q (1 - P_f)}{e^{-r} \omega(e_n - e_m) LGD E_q 1_{\{N_{D,S} \leq \psi\}} (1 - P_f | N_{D,S} \leq \psi)} \end{aligned} \quad (19)$$

$$\begin{aligned} & = \frac{K}{V_m - V_n} \times \frac{E_q (1 - P_f)}{E_q 1_{\{N_{D,S} \leq \psi\}} (1 - P_f | N_{D,S} \leq \psi)} \\ & = \frac{K}{V_m - V_n} \times \frac{Q(\text{bank survives})}{Q(N_{D,S} \leq \psi, \text{bank survives})} \end{aligned} \quad (20)$$

A comparison of the last line with proposition 1 shows that because the securitization provides insurance against loan defaults, the amount of each loan that the bank must hold to make monitoring incentive compatible is larger in a securitization than is required with loan sales. Therefore, in our framework with fixed monitoring costs K , if face value S , varied by loan, then some loans would have too small a face value to be included in a securitization, but part of the loan might still be sold in the loan sale market.

To model the bank's funding needs and portfolio choices, as before we will assume the bank originates $N + N_O$ loans; it then chooses the number of transparent loans N_s that it wishes to cover through credit protection via an SCLO. For each loan that is covered, the bank chooses an identical amount θ_s to retain on balance sheet, and sells the rest in the loan sale market. It also chooses ψ , the number of defaults on the SCLO's assets that the bank will absorb before receiving protection.

For the $N - N_s$ loans that are not covered by the securitization, the bank retains θ percent of each loan on its balance sheet, and sells the rest in the loan sale market.

These choices generate the following funding requirements that need to be satisfied through debt and equity issuance:

$$TFC_{SCLO} = (N - N_s) FC(\theta) + N_s FC(\theta_S) + N_O FC(S) + (N - N_s) + F(\psi, \theta_S, N_s). \quad (21)$$

The bank's loan portfolio and securitization together generate payoffs

$$VP(N_s, \theta, \theta_S, \psi) = \sum_{j=1}^{N_O} SX_j + \sum_{i=1}^{N-N_s} \theta X_i + \text{Max} \left[\sum_{j=1}^{N_s} \theta_s X_j, \theta_s (N_s - \psi LGD) \right].$$

Following the same approach as in section 4, if the bank meets part of its financing needs by issuing debt that promises to pay $D_1 = (1 - \alpha)TFC_{SCLO}$ at time 1, then the current value of the debt D is given by:

$$D = e^{-r} E_q [(1 - \chi_D) D_1 + \chi_D \phi VP(N_s, \theta, \theta_S, \psi)]. \quad (22)$$

Equity holders' share of funding costs is $TFC_{SCLO} - D$, and the spread on the debt is $s_D = \ln(D_1/D) - r$, where χ_D is an indicator function for the bank's insolvency. With this specification, when the bank securitizes via an SCLO, the bank chooses θ , θ_s , N_s , ψ , and α to maximize equity holders' value, $V_{E,SCLO}$, given by:

$$V_{E,SCLO} = (1 - \tau)e^{-r} E_q [VP(N_s, \theta, \theta_S, \psi) - D_1]^+ - (TFC_{SCLO} - D), \quad (23)$$

subject to the incentive compatibility constraints for monitoring given in equations 19 and 15.

CLO

Here we model securitization by using a stylized collateral loan obligation. In the CLO formulation, the bank sells some of its loans to a special purpose vehicle, or SPV. The cashflows of the loans are tranching; investors purchase the tranches from the SPV, and they are distributed accordingly. For simplicity, assume that N_S loans are sold to the SPV

and that the face value of each loan's securitized part is θ_S as above, and assume that the cashflows from the loans are cut into an equity tranche and a senior tranche. In time period 1, the senior tranche of the CLO receives cashflows $\min\left(\omega\theta_S(N_S - \psi LGD), \sum_{j=1}^{N_S} \theta_S X_j\right)$. Here, ψ represents the amount of subordination that protects the senior tranche because the senior tranche does not experience credit losses until the number of defaults exceed ψ . The equity tranche receives any income that is left over after the senior tranche has been paid. This implies the equity tranche receives cashflows $\left[\left(\sum_{j=1}^{N_S} \theta_S X_j\right) - \omega\theta_S(N_S - \psi LGD)\right]^+$ at time 1.

The value of the senior and equity tranches of the CLO are valued in the same way as a bond and stock. The bank's incentive to monitor the CLO requires additional discussion. As before, we make a "large CLO" assumption which in this case takes the form that whether the equity tranche becomes exhausted does not depend on whether the bank monitors a single loan. Similarly, we assume that whether the bank monitors a single loan in the securitized portfolio does not affect the probability that the bank becomes insolvent.

Given this large CLO assumption, let $G_{f,e}$ denote the probability that the bank and equity tranche are both solvent conditional on f , and let $1 - P_f$ denote the probability that the bank is solvent conditional on f . It follows that $1 - P_f \geq G_{f,e}$. As before, we assume that the bank either uses the funds for monitoring a single loan, or it instead invests the funds risk-free for one period. If the bank monitors the loan, then its value to bank equity holders is given by:

$$(1 - \tau)e^{-r} \sum_f \omega\theta_S[1 - (\gamma_f + e_m)LGD]G_{f,e}q_f.$$

If the bank chooses not to monitor the loan, it receives:

$$(1 - \tau) \left\{ e^{-r} \sum_f \omega\theta_S[1 - (\gamma_f + e_n)LGD]G_{f,e}q_f + K \sum_f (1 - P_f)q_f \right\}$$

Note that the second term represents the savings to the bank from not monitoring, and that the equity holders of the bank save money by not monitoring under those contingencies where the equity tranche becomes exhausted but the bank remains solvent. Rearranging the two expressions following the approach in equation 19 then shows that incentive compatible monitoring requires:

$$\theta_s \geq \frac{K}{V_m - V_n} \times \frac{\sum_f (1 - P_f) q_f}{\sum_f G_{f,e} q_f} = \frac{K}{V_m - V_n} \times \frac{Q(\text{bank survives})}{Q(\text{equity tranche pays, bank survives})} \quad (24)$$

This shows that the size of loan in the CLO that is required to make monitoring incentive compatible is greater than is required without securitization. The intuition for the result is that the senior tranche investor insures some of the bank's losses from default, and this reduces the bank's incentives to monitor.

To model the bank's financing costs that are covered by debt and equity holders, we assume that the bank fully sells the N_s loans that it securitizes, by selling θ_s dollars of face value of each securitized loan to the SPV, and $100 - \theta_s$ dollars of face value in the loan sale market; it then buys back the first loss piece of the securitization. The securitization transactions generate financing costs $N_s FC(0) + VFLP$, which is the sum of the financing costs of monitoring and holding 0 dollars of face value of N_s securitized loans on balance sheet plus the costs of purchasing back the first-loss piece of the securitization, VFLP, and of monitoring the loans. Additionally, as in the SCLO, the bank's holdings of the loans that are not covered by the securitization are θ . These transactions generate total financing costs, TFC_{CLO} that are split between debt and equity holders:

$$TFC_{CLO} = N_O FC(S) + (N - N_s) FC(\theta) + N_s FC(0) + VFLP$$

where VFLP (value of first loss piece) is the value of the equity tranche of the CLO, as given by

$$VFLP = e^{-r} E_q \left[\sum_{j=1}^{N_s} \omega \theta_S X_j - \omega \theta_S (N_s - \psi LGD) \right]^+.$$

The payoff of the bank's portfolio at time 1 when it participates in the CLO is given by:

$$VP(N_s, \theta, \theta_S, \psi)_{CLO} = \sum_{j=1}^{N_O} S X_j + \left(\sum_{i=1}^{N-N_s} \theta X_{i+N_O} + \left[\sum_{k=1}^{N_s} \theta_S X_{k+N_O+N-N_s} - \theta_S (N_s - \psi LGD) \right]^+ \right),$$

where the first term is the payoff of the opaque loans and the second and third terms (in braces) contain the payoffs on those transparent loans that the bank chose to not securitize, as well as the bank's payoff from the first loss-piece in the securitization.

From this point, it is straightforward to value the banks debt, and equity. The value of the equity holders' stake in the bank net of their additional financing costs, denoted by $V_{E,SEC}$, is given by

$$V_{E,SEC} = (1 - \tau)e^{-r}E_q[VP(N_s, \theta, \theta_s, \psi)_{CLO} - D_1]^+ - [TFC_{CLO} - D]. \quad (25)$$

When financing with a CLO, the bank chooses $N_s, \theta, \theta_s, \alpha, \psi$, to maximize the equity holders' value $V_{E,SEC}$ subject to the incentive constraints 24 and 15.

In the next section, we solve for the optimal financing with securitization and analyze how it affects the banks choices. The following section studies the effects of securitization from an empirical perspective.

6 Results from Model Simulation

In this section, we first study the properties of the model in our basic two-period setting, and then we extend the model to allow for an infinite number of time-periods.

6.1 Two-Period Setting

As a baseline for our results, we study how a bank that can sell and securitize all of its assets differs from a bank that can sell assets but cannot securitize. The bank's performance in the no-securitization case was studied for the parameterization of the economy in section 4.1, and is presented in Table 7, panel A. The effects that SCLO and CLO securitization have on bank performance are presented in panels B and C. To generate these results, we solved the bank's optimization problems for SCLO and CLO securitization [equations (23) and (25)] for a range of different financial distress costs. The optimization of the bank's parameters was performed through a grid search over a 5-dimensional parameter space.

The results on SCLO securitization illustrate the pronounced effect that securitization can have on bank profitability and solvency. Our principal result is that the opportunity to use SCLO securitization substantially alters the banks risk profile, profitability, and capital structure by helping the bank to reduce its tail risk. In the example, securitization helps the bank to eliminate tail risk, which then allows the bank to use more debt finance, which is

favored for tax purposes, while still remaining solvent. By avoiding tax costs, this substantially increased the value of the bank to equity holders (Table 7, panel B). In our analysis we restrict debt issuance to the amount required to meet the bank’s financing needs that are not covered by loan sales and the securitization. In the maximization, the bank hits this maximum debt constraint in choosing its capital structure.¹⁵

To illustrate how SCLO securitization transfers tail risk outside of the bank, in this version we reference our example but use a figure that was created for a similar example in an earlier draft of our paper. The figure shows that when securitization is not available, and bankruptcy costs are high ($\phi = 0.95$), equity financing is substantial and as result equity holders bear substantial tail risk. This tail-risk is best represented by the distribution of the present value of equity-holder earnings under the probability measure Q since this measure scales the probabilities of earnings-outcomes by investors’ marginal utility (Figure 1, panel A).¹⁶ Equity holders earnings distribution under Q has a fat left-tail because of the substantial losses that equity holders earn in state 3, and because of the high loss of marginal utility in that state.

When the bank can securitize via an SCLO, it uses it to truncate the distribution of the bank’s losses, effectively eliminating tail risk (Figure 1, panel B). Because the bank’s shareholders buy insurance when they enter into an SCLO, it provides them with downside protection and it reduces their gains on the upside—this is represented by a leftward shift in part of the distribution of equity holders’ net earnings under both the Q measure, as well as under the true “physical” probabilities (Figure 1, panels B, C, and D). Despite the leftward shift in physical probability, the use of the SCLO to hedge risk substantially increases the bank’s profit.

The availability of SCLO securitization also alters the bank’s incentives to use loan sales. The incentive constraints for bank monitoring when there is an SCLO require the bank to hold a greater part of the loans that it securitizes on balance sheet than would be required in the case of loan sales. In our example, the amount of each loan’s face value that has to be held on balance sheet when there is SCLO securitization is much greater than is required without securitization (Table 7, panels A and B). Consequently, the availability of SCLO securitization leads to a large drop in loan sales.¹⁷

¹⁵In theory, the bank could issue more debt than its financing needs and then provide a distribution to its equity holders at time 0. For simplicity, we rule out this possibility. In future versions, we may allow distributions at time 0.

¹⁶The present value of equity-holders earnings is defined as the value of equity holders after-tax dividends discounted at the risk-free rate minus equity holders initial investment at time 0.

¹⁷ in the example, because the bank chose to securitize all of its assets, θ , the bank’s holdings of loans

As for the CLO case, some of the results are qualitatively the same as in the SCLO case, and some are dramatically different. In both sets of results, securitization increases the banks profits by similar amounts, and in both cases the bank sheds tail risk by transferring it to investors in the CLO. However, the bank’s solvency risk, and capital structure are very different in the two cases. In the case of the CLO, the bank chooses to securitize all of its assets, and the equity tranche of the CLO is the bank’s only asset. The residual funding costs that are needed to finance its position are a *de minimis* 4 dollars (Table 7). If the bank meets these financing costs with any positive amount of debt, then the debt will only default when the first loss tranche of the CLO is exhausted—and in this circumstance there will be no recovery on the debt and bankruptcy costs will not influence the bank’s decision. As a result, the optimal financing decision is to meet the full residual financing costs with debt and for the bank to have a high risk of bankruptcy.¹⁸

The results on CLO securitization show that the bank’s ultimate solvency risk when it securitizes depends on how the securitization decision interacts with the bank’s choices of debt and equity to meet its residual financing needs. In our two-period model, because the bank does not care about its franchise value, CLO securitization caused the bank to take substantial solvency risk to meet its residual financing needs even when the potential gains from increasing solvency risk are very small. When the bank cares about its franchise value, we expect an optimizing bank would take far less risk than is implied in our two-period model.

To further analyze how securitization affects the risk of the bank, we studied its impact in a setting when there are $N_O = 60$ opaque loans that must be held on balance sheet and $N = 30$ that can be sold or securitized. In all cases, securitization substantially improved bank profitability (Table 8), and for both CLO and SCLO securitization, it shifted the tail risk of the bank’s earnings stream away from bank equity holders (Figure 2). Our results for how it affected bank solvency were more ambiguous. In the case of SCLO’s, the ability to securitize assets reduced bank default probabilities in some circumstances, but in other circumstances default probabilities increased. In the case of CLO’s, profits increased by about the same amount, or slightly more as in the SCLO case and bank default probabilities increased in all circumstances. We are still working on developing intuition for the results

that are not securitized is listed as -- in Table 7. Note also that when there are 90 loans $\alpha = 0$. Because of the way that we parameterize and solve our model, this corresponds to a small amount of equity financing. To see why recall that at time 1, the promised payment to debt holders is $D_1 = (1 - \alpha) * TFC$ which, has value $D < TFC$ at time 0 when $\alpha = 0$. Since equity holders pay financing costs D , then equity holders pay financing costs $D - TFC > 0$ when $\alpha = 0$.

¹⁸Our grid search did not allow the bank to choose full debt financing in this case.

when some of the assets are held on balance sheet. In the next subsection, we study how these results change in a simple infinite-period extension of our model.

6.2 Multi-Period Model

The extended version of our model contains $t = 1, \infty$ time periods. Each period t is decomposed into subperiods t_0 , and t_1 , that are analogous to periods 0 and 1 in our two-period model. During subperiod t_0 the bank originates loans and chooses its financing arrangements; between the subperiods the bank monitors the loans; in subperiod t_1 the loans mature, the bank distributes its cashflows to debt and equity holders, and then period t ends. At date $t + 1$, the same process repeats itself provided that the bank did not default on its debt at the end of period t . If the bank defaults, then we assume the bank is shut down.

To economize on notation, let \mathcal{A} denote the set of feasible actions that the bank can take, and let $a \in \mathcal{A}$ denote one of the elements of the set. The set of actions incorporate the financing arrangements that are available to the bank, and any restrictions are due to budget or incentive constraints. For each t and a , let $\Pi(a)$ denote the expected profit earned by equity holders, discounted to the beginning of period t_0 , and let $PS(a)$ denote the probability that the bank remains solvent during period t .¹⁹

We assume that the bank chooses a to maximize equity holders risk-adjusted discounted expected stream of all future profits, denoted by J . Note that J is the franchise value of the bank because it represents the value of the stream of rents that the bank earns because of its monopoly power in monitoring. Because the bank's problem is stationary, its discounted expected stream of profits starting from any time t is its expected discounted profits within the period plus δ times the probability it survives, times its expected discounted profits. In other words, banks maximize J , which is the solution to:

$$J = \max_{a \in \mathcal{A}} \Pi(a) + \delta PS(a) J.$$

Rearrangement shows that in the infinite period setting banks maximize:

$$J = \max_{a \in \mathcal{A}} \frac{\Pi(a)}{1 - \delta PS(a)}. \quad (26)$$

¹⁹The profits consist of the discounted expected cashflows that equity holders receive at time t_1 less the amount of financing that they provide at time t_0 .

Note that in the two-period version of our model, banks were only concerned with maximizing within period profit, $\Pi(a)$. In the multiperiod setting they are also concerned with $PS(a)$, the probability that the bank survives.

To see how this changes our results, we solved the bank’s dynamic maximization problem 26 when the parameters for each subperiod t_0 and t_1 , and the discount factor, $\delta = 0.99$, were chosen to be the same as in our two-period example (section 4.1). As in the previous subsection, we study the bank when it cannot securitize, and when it securitize using SCLO’s and CLO’s, and when some of the banks loans are opaque.

When the bank cares about maximizing its franchise value, our results change in three ways. First, in all the cases we consider, the bank’s probability of insolvency is reduced relative to a specification when banks do not care about franchise value.

Second, when all loans can be securitized, banks use securitization and their debt and equity financing arrangements to fully eliminate bank insolvency risk (Table 9, panels B and C). In the case of the SCLO, this is what was expected based on the results from the two-period version of the model. In the case of the CLO, in the two-period model it incurred a substantial risk of insolvency in order to secure a small cost savings. When franchise value matters, it is no longer optimal to incur a high risk of insolvency. Instead, in the CLO case, the bank meets all of its residual financing costs through the issuance of equity, and drives its insolvency risk to 0. This result shows that modeling the bank in a multi-period setting can significantly alter inference about how securitization affects solvency risk. The result also shows that in some circumstances securitization can generate a reduction in the bank’s on-balance sheet leverage.

Our third finding is that when some loans are opaque then in our multiperiod model, SCLO securitization reduces the bank’s insolvency risk in all cases, while CLO securitization raises insolvency risk relative to when there is no securitization (Table 10). These results show that even in a multiperiod setting, some forms of securitization can increase risk.

Careful examination of our results in a multi-period setting also show that when the bank can choose its form of securitization, the form that maximizes the bank’s franchise value in all circumstances lowers the insolvency risk of the bank relative to what it would be if securitization was not available (Table 9, panels A and C; and Table 10, panels A and B). Hence these results suggest a positive role for securitization. In the next section, we test whether this positive role for securitization is borne out in the empirical data.

7 Empirical Results

7.1 Data

We use FR Y9-C US bank holding company (BHC) data from the second quarter of 2001 to the third quarter of 2006 to analyze the predictions of our theoretical model on loan sale and asset securitization. We study BHCs at a consolidated level because loan sale and securitization within a BHC group may not be subject to the same informational and agency problems. Our data start from 2001 because the Y9-C did not report loan sale and securitization by asset type until then²⁰. The schedule HC-S of Y9-C reports the type of sold and securitized assets of 1-4 Family Residential Mortgage Loans (Mortgage), Home Equity Lines (HEL), Commercial and Industrial loans (C&I), Credit Card, Auto, and Other Consumer Loans (Other). These assets are sold with recourse or other seller-provided credit enhancements and not securitized. We believe these type of sold loans are more relevant to our paper. Securitizations are recorded by their outstanding principal balance of assets sold and securitized with servicing retained or with recourse or other seller-provided credit enhancements. These observations differ from loan sale which exclude securitization^{21,22}.

7.2 Loan sellers vs securitizers, and securitizers vs non-securitizers

In reality, banks are most likely to hold both opaque and transparent loans in their loan portfolio. A solvent bank also has incentive to choose funding and risk management tools to secure its franchise value. We thus rely on our main model predictions that banks will choose the most profitable securitization form. In addition, the most profitable securitization form lowers the probability of the bank's insolvency. Banks that securitize will be able to use

²⁰We merger adjust and delete observations for which risk weighted capitals, leverage ratio, loan growth rate, return on assets are more than 100%, or loan to deposit ratio is more than 10.

²¹For example, securitizing mortgage differs from sale of mortgage in that securitized mortgages are sold into a securitization, while sale of mortgage is sale, but not into a securitization. In the first case of selling into a securitization the seller may retain the servicing rights for the mortgage. In both cases there may be some recourse or credit enhancement used to make the sale. Traditional accounting would not allow a seller to record the sale if there was any chance the seller would have to take the asset back. Now, banks are allowed to get sale treatment even though there may be some credit enhancement. The goal of tracking securitization and asset sales is to see if any sales leave the bank exposed to having to take the asset back (reversing the sale). The biggest difference here is that the first one is for a securitization while the second one is just a sale of a mortgage asset.

²²There is also one column that reports the "all other loans, all leases, and all other assets" which is omitted in our analysis because we cannot separate loans from leases. We combine Auto with Other because we compare the sold assets with on balance sheet assets which do not separate Auto from Other loans.

more leverage. Our final prediction is that when banks can securitize, they would prefer to choose securitization that involves pooling and tranching instead of loan sales.

The model’s predictions on loan sales versus securitization is relatively straightforward to test. If banks prefer securitization to loan sales, then for those asset classes where both loan sales and securitization take place, we would expect the amount of securitization activity to be much greater than the amount of loan sale activity. To normalize the scale of these activities, we measure both activities relative to on-balance sheet holdings of the same class of assets. Our main finding is that securitization dwarfs loan sales in our data, with ratios of the two activities often exceeding 20 to 1. For the Mortgage and Credit Card asset classes, there are even a few quarters in which securitized assets are more than 100% of on balance sheet assets (Table 5).

Before analyzing the benefits and costs of securitization, we compare BHCs that securitize with those that do not securitize along a number of dimensions including their size, their tendency to specialize in originating particular classes of loans, credit risk, profitability and leverage (Table 11). All our variables are based on quarterly data series for each bank. A BHC is assigned as a mortgage securitizer if we observe its mortgage securitization activities in any quarter. BHCs assigned as other types of securitizers are defined in a similar way. Those that ever securitize any type of assets are Ever securitizers, while those never securitize are Never. We have a total of 2302 bank observations with 147 Mortgage, 24 HEL, 32 C&I, 34 Credit card and 48 Other Securitizers. 188 are Ever-securitizers and 2113 banks are Never-securitizers of any type of assets.

Most of the securitizers do not securitize in all quarters. This can happen when a securitizer is accumulating loans to package for securitization, or if there are periods of time when securitization is less profitable. To compare the securitizers and non-securitizers, we calculate the time-series averages of the variables for each BHC and then take the cross-sectional means of securitizers and non-securitizers. The statistical differences among securitizers and non-securitizers is based on the difference of the means across the two groups. Some large p-values indicate that the mean difference are insignificant. However, this is expected since the securitizers sample is much smaller than the non-securitizers. The percentage mean differences in the characteristics is used as a measure of economic significance²³.

The most robust difference between securitizers and non-securitizers of any asset types

²³This is calculated as the ratio of the difference between mean of the securitizers and non-securitizers over 0.5 times the sum of mean of securitizers’ and non-securitizers’.

is that securitizers are significantly larger than non-securitizers²⁴. Size is measured as the logarithm of the total assets. Securitizers may also reflect that asset securitization requires economy of scale to contribute up-front cost for underwriters and rating agencies. Though securitizers are large in size, their loans as percentage of total assets is lower than the non-securitizers. This may suggest that large BHCs frequently shift loans off the balance sheets for sale or securitization, or they engage more in business other than loan origination.

In addition to size, securitizers also have much higher average percentage of the type of loan they securitize on their balance sheets than the non-securitizers. The percentage of mean differences between securitizers and non-securitizers are significant and vary from 11.0 % (Mortgage) to 184.5% (Credit Card). Consistent with financial intermediation theory, this suggests that specialization in loan origination may drive securitization.

Our theoretical results suggest that securitizers need to hold less capital against tail risk or unexpected credit loss. It is difficult to calculate the sensible measure of tail risk. Instead, we measure both the expected and the unexpected credit loss (tail risk) in order to analyze both the mean and the tail of the portfolio loss distribution. The two measures for expected loss are the forward looking ratio of provision to total loans and the backward looking ratio of nonaccrual plus charge-off to total loans. We follow the literature by approximating the tail loss as the time deposit premium which is the difference between the interest rates on time deposit below (small) and above (large) US\$100,000²⁵. Gilbert, Meyer and Vaughan (2002) listed a total 12 papers with evidence pointing to risk pricing by large time deposit holders (their Table 2). The time deposit premium is a noisy measure of the spread that uninsured depositors require for bearing the solvency risk of the bank²⁶.

Both the provision and charge off ratios are statistically and economically significantly higher for securitizers than non-securitizers except the provision ratio of Mortgage. This

²⁴Minton et al (2004) using US data also find that large commercial banks are more likely to securitize. Using CLO data from 17 European countries, Bannier and Hansel (2006) report that large banks are more likely to securitized CLOs. Martin-Oliver and Saurina (2007) use Spanish bank data also find size is positively related to asset securitization.

²⁵We could use capital minutes provision as a measure of unexpected loss. However, we do not know the loss distribution such that how much the tail loss that capital is assumed to cover. In addition capital as a measure of solvency risk has other problem, for example, when banks approach failure, and examination results often dictate the need for increased loan loss recognition which, absent an injection of capital, erodes the bank's capital adequacy measures (Dahl, O'Keefe, and Hanweck (1998), and Gunther and Moore (2000)). Nevertheless, when a bank's condition weakens, it's cost of deposit funding often rises. Thus, the time deposit premium maybe a better measure than capital.

²⁶A few caveats are associated with this measure. First, the above US\$100,000 time deposits may be insured if they are held in joint accounts. US BHC data do not provide information on this. Second, we do not have information on maturity and liquidity of these time deposits.

results could, for example, imply that securitization enables the securitizers to take more credit risk than non-securitizers on average. Alternatively, our model does not capture all other risk aspects of the securitizers and non-securitizers. High observed charge-off and provisions may also reflect a size effect in that larger banks are more likely to take credit risk than small banks²⁷. Securitizers have a lower time deposit premium than the non-securitizers. The difference can be as high as 134% (C&I). However, the difference of time deposit premium between securitizers and non-securitizers for Mortgage, Credit Card, Other and Ever are not statistically significant.

To study the profitability of securitizers and non-securitizers, we focus on return on equity (ROE). (We also examined ROA and obtained the qualitatively same results). The ROE for securitizers ranges from around 11.4% (Mortgage, Securitizers) to 13.57% (Other, Securitizers) which is higher than that of the non-securitizers at around 10%. However, the large p-values indicate that the difference between securitizers and non-securitizers are statistically insignificant for Mortgage, C&I and Credit Card.

Our model predicts that securitization frees up banks to use more leverage while avoiding distress risk. The mean leverage ratio of securitizers and non-securitizers are all above 89%. Leverage ratio of Mortgage, HEL and C&I securitizers are higher than non-securitizers but statistically insignificant, while a reverse pattern exists for Credit Card and Other. The Ever securitizers also have a low leverage ratio than the Never-securitizers, though the difference is insignificant. Our analysis shows that leverage and securitization decisions are inter-related. If there is a third factor (such as perhaps bank size) that are related to leverage and to why some banks do not securitize, it may also help to explain our leverage results. This requires further analysis.

The final variable that we study is funding liquidity as measured by the ratio of total loans to total deposits. Securitization and loan sales activities are alternatives to deposits as a source of funding liquidity. Therefore, we should expect securitizers to have higher liquidity ratios since they need fewer core deposits to fund their balance sheets than non-securitizers. The data for all asset classes support this view, suggesting that securitizers rely less on traditional sources of funding liquidity than the non-securitizers.

Our theoretical model's prediction is that securitizers have a lower solvency risk, higher profitability and leverage ratio than non-securitizers is based on the assumption of holding everything else constant. The above comparison between securitizers and non-securitizers

²⁷Bannier and Hansel (2006) use credit risk provision over net interest income as a measure of credit risk also find that high credit risk banks are more likely to securitize CLOs.

does not control for everything else. The next section attempts to apply the empirical analysis more closely to the assumption of our theoretical model.

7.3 Quantifying the benefits and costs of securitization

The earlier sections of our paper established a theoretical link between securitization and solvency risk (tail risk), bank's profitability and leverage ratio. In this section, we use BHC data to analyze these linkages empirically.

We quantify the benefits or costs of securitization by comparing the averages of the observed securitizers' solvency risk, profitability and leverage ratio with hypothetical values that are calculated by assuming the securitized loans were put back on balance sheets. As one illustration of our approach, we assume that there is a relationship between a bank's solvency risk and the composition of its balance sheets, including the share of each type of loans held on the balance sheet (loan shares)²⁸. We use the non-securitizers data to estimate this relationship. We then use this estimated relationship to compute the bank's solvency risk if its securitized loans were placed back on the balance sheet. This method allows us to predict the bank's solvency risk if the securitizer did not securitize its loans. We then compare the predicted values with the average of the observed securitizers' solvency risk. The difference between the observed and predicted values is the measure of the quantitative impact of securitization. We apply the same exercise to bank's profitability, and leverage ratio.

We still use provision ratio and time deposit premium as our measures of solvency risk. Following the literature, we assume our variable of interest, Y , is a linear function of loan shares and other controls.

$$Y = \beta_0 + \beta_1 \frac{Mort}{Loans} + \beta_2 \frac{HEL}{Loans} + \beta_3 \frac{C\&I}{Loans} + \beta_4 \frac{Credit}{Loans} + \beta_5 \frac{Other}{Loans} + \text{other variables} \quad (27)$$

where Y is solvency risk, profitability or leverage ratio. The other variables are the share of loans to assets, size, and the cost of funding measured by the rate on deposits, and interest rates on small and large time deposits. The above model specification is based on

²⁸The loan share variables do not sum to 1 since we only include the five types of loans with available securitization information.

the empirical model of Cebenoyan and Strahan (2001) for loan provision ratio²⁹, Wheelock and Wilson (2000), Estrella, Park and Peristiani (2000) for bank solvency risk³⁰, Cebenoyan and Strahan (2001) for ROE³¹, Flannery and Rangan (2004), Gropp and Heider (2007) for leverage ratio³².

Again, we calculate the benefits of a securitization program by taking the time-series averages of both the dependent and explanatory variables for each BHC as our sample. We thus report the between estimator, which exploits the full panel data set but estimates the regression using the time-series averages.

We estimated five model specifications of equation (27) for the non-securitizers using OLS³³. The results are reported in Table 12. Model (1) includes the shares of Mortgage, HEL, C&I, Credit Card and Other to loans, and size as control. Model (2) adds the loan to assets to Model (1), Model (3) adds the rate on deposit to Model (2), and Model (4) and (5) replace the rate on deposit with small and large time deposit rate respectively.

It is important to emphasize that each coefficient of the loan share variable in the regression for provision ratio, time deposit premium, ROE and leverage ratio cannot be interpreted in isolation since if the share of one type of loan is increased, the others must necessarily decreased.

Across the five models, provision ratio is negatively correlated with the share of Mortgage and HEL loans, large time deposit rate, and size, while positively correlated with the share of C&I, Credit Card and Other loans, rate on deposit and small time deposit rate. To control for the problem loans on solvency risk, we also add the rates of problem loans which

²⁹Their dependent variable is the volatility of provision ratio. We use the provision ratio since we attempt to examine the marginal impact of securitization on provision. The additional variables in their paper are capital asset ratio and dummies variables which indicate whether or not a bank is a loan seller, buyer or both, whether or not a bank belongs to a multi-BHC or multi-state BHC.

³⁰These papers also include the equity to asset ratio, an important variable in explaining bank failure, ROA and problem loans. We do not include equity to asset ratio and ROA since we do not know how these two ratios change if the securitized loans were put back on balance sheet.

³¹The additional variables are capital asset ratio and dummies variables which indicate whether or not a bank is a loan seller, buyer or both, whether or not a bank belong to a multi-BHC or multi-state BHC.

³²Flannery and Rangan (2004), Gropp and Heider (2007) both regress leverage ratio on market to book asset ratio, profitability, risk, and size. Most of our non-securitizers are not publicly traded BHCs. Thus, we cannot construct the market to book ratio. However, our other variables can approximate the profitability and risk.

³³Alternatively, we use Tobit regression for leverage ratio and obtain almost identical results as OLS. We realized that there are a few large banks reported negative provision since they took out provision due to high level of previous reserves. We thus, report the OLS results for provision. We also separately estimate the same relationship of non-securitizers for each asset type, Mortgage, HEL, C&I, Credit and Other. The results are similar and available upon request.

are loan pastdue 30-89 days, 90 days plus, and nonaccrual and charge off loan ratios on time deposit premium regressions. The coefficients on the three problem loan ratios are all positive. The F-statistics (not reported but available upon request) reject that these three coefficients are jointly insignificant across five models, indicating that banks with high share of problem loans hold more loan loss provision. The adjusted R-squares are above 78%. Alternatively, we drop the three measures of loan quality in the regressions, and our results are still qualitatively and quantitatively hold.

The share of mortgage, HEL and Other loans, rate on deposit, large time deposit rate are positively related to time deposit premium. Share of C&I, Credit Card loans, small time deposit rate, share of loans over assets and size are negatively related to time deposit premium. The 90 days plus pastdue and nonaccrual and charge off rates are positively related, while 30-89 days loan pastdue rates are negatively related to time deposit premium. The F-statistics reject that the three coefficients are jointly insignificant across four models except Model (5). The adjusted R-squares vary from 20.2% to 91.2%. Adding small and large time deposit rate significantly increases the model's explanatory power.

ROE is negatively related to the share of Mortgage, HEL, C&I and Other loans, rate on deposit, and large time deposit rate, while positively related to the share of Credit Card loans, share of loans to assets, small time deposit rate and size. The adjusted R-squares vary from 6.8% to 11.9%.

The leverage ratio are negatively related to the share of Mortgage, C&I, Credit Card, Other loans, rate on deposit and large time deposit rate, and positively related to share of HEL loans, loan to assets, small time deposit rate and size. The adjusted R-squares varies from 2.7% to 10.3%.

Next, we apply the estimated relationship between provision ratio, time deposit premium, ROE and leverage ratio to securitizers assuming that the securitizers put the securitized loans back on balance sheet. Adding back these securitized loans will change assets, total loans, share of all type of assets and share of problem loans. We recalculated the time series average of these new variables labeled with "A-" for augmentation. Table 13 reports the mean, standard deviation of securitizers' time series average. The columns labeled with "% Δ " are the percentage change in observed values when securitized assets are added back on balance sheet.

Mathematically, adding back any type of securitized asset will increase total assets, loans, the share of loan to assets. In particular, adding back securitized mortgages will increase

the share of mortgage loans and decrease shares of other type of loans. However, whether share of problem loans increases when securitized assets are retained on the balance sheet is less a clear cut because it depends on higher quality assets are securitized or retained on balance sheet³⁴. When Mortgage, HEL and C&I are moved on balance sheet, average loan quality in each category increases by some measure but decreases by other measures. For example, HEL has an increased 30-89 days pastdue, 90 days plus pastdue ratio but a decreased nonaccrual and charge off ratio. However, for Credit Card and Other, All these three measures of problem loan consistently show that the average quality of securitized Credit Card and Other loans are worse than that of the retained on balance sheets³⁵.

Table 14 presents results on how solvency risk, ROE and leverage ratio are affected by putting the securitized assets back on balance sheet. The entities in bold face in the table present the observed values of these variables when assets are securitized, while the rest of the values are the predictions based on the five models. For example, the first column indicates that the predicted provision ratio for Mortgage securitizers, across the five models, are above 0.29%, while the observed mortgage securitizers on average has a provision rate 0.25%.

Consistent with our model’s prediction on bank solvency risk, adding the securitized asset back on balance sheets would increase the loan provision ratio. Such a pattern is observed across all the five asset classes. For example, the predicted provision ratio for Mortgage is 4 to 7 basis points (bps) higher than that of the observed. The largest provision rates increase is 32 bps for Credit Card securitization. Alternatively, when solvency risk is measured as the time deposit premium, securitization of Mortgage, HEL and C&I also benefit banks with a lower time deposit premium in most model specifications. The reduced premium or funding cost for securitizers are around 50bps in most cases. These numbers are within the range reported by Elghanayan (2006) who documented that the rated banks can save 20-80 bps in funding costs by issuing securitization rather than debt, while the saving for unrated banks can be well above 100 bps. However, the predicted values for Credit Card and Other are not

³⁴The share of added back problem loans is calculated, for example, for mortgage as the ratio of the sum of on balance sheet problem loans plus the securitized problem mortgages divided by the sum of on balance sheet loans and securitized mortgages.

³⁵However, we realize that to compare the credit quality of the securitized versus the on balance sheets assets poses a number of data challenges. First, with aggregate level data, it is impossible to separate the truly kept on book loans from the temporarily kept on book loans which are intend to be put into a securitization pool. Second, the vintage of the securitized loans can be quite different from the on balance sheet loans. For example, unseasoned credit cards have a larger credit risk than the seasoned ones. Without adjusting seasonality, the comparison can be problematic. Third, there maybe significant heterogeneity of both securitized and on balance sheet assets. For now, we just report what we observe in the data and leave these difficulties for the future research.

consistent with our model’s prediction that securitization lower banks’ solvency risk.

Comparing the predicted and observed ROE of Mortgage, HEL and Other securitizers also lends support to our model’s prediction that securitization enables banks to earn higher profits. Securitization enables banks to increase ROE by 1pb to 142 bps. The results of C&I and Credit Card do not support our model’s predictions. Securitization enables banks to increase their leverage ratio from 43 to 153 bps except for Other. These results of leverage ratio mirror the results of ROE. Increasing leverage ratio also increases ROE. In summary, our theoretical model is broadly supported by the empirical analysis.

We also experimented by putting all the securitized assets back on the balance sheet. The last column in Table 14 compares the predicted and the observed values of provision ratio, time deposit premium, ROE and leverage ratio. The predictions of our model are reported in the last column. All five models’ prediction support that securitization reduces banks provision ratio. However, four out of five models reject the prediction for time deposit premium, three out of five models reject ROE and all five models reject leverage ratio. The last three columns in the table shows that the impact of putting back all securitized loans creates a large range of changes in some of the securitizers variables that we use as regressors, with values as low as 0.9% less (Other) or as high as 147% more (90 days plus pastdue rate). Because the regressors are nonlinear functions of changes in the balance sheet composition, we suspect that our model is a local approximation, it may be inappropriate when applied over a large range of changes in these variables.

8 Conclusion

In this paper we have presented a theoretical model of bank securitization. Our preliminary results show that the two methods of securitization both increase bank profitability by similar amounts, but they have different implications for bank solvency. This suggests that banks with substantial franchise value will prefer to engage in securitization activities that will increase profitability and reduce tail risk.

We used BHC data from the second quarter of 2001 to the third quarter of 2006 to analyze the predictions of our theoretical model on loan sales and asset securitization. Consistent with our model’s predictions, we found that banks prefer securitization to loan sales. We also compared the characteristics of securitizers and non-securitizers across five securitized asset classes (Mortgage, HEL, C&I, Credit Card and Other). Securitizers have significantly

more assets than non-securitizers, while they hold less loans. Consistent with financial intermediation theory, we also found that securitizers tend to specialize— and have much higher average percentages of the type of loan they securitize on their balance sheets than the non-securitizers. Securitizers have higher expected credit loss than non-securitizers, but tend to have lower solvency risk. Securitizers also have higher ROE but their leverage ratio are not uniformly higher than non-securitizers across the asset classes. Consistent with theories that securitization and loan sales activities are alternatives to deposits as a source of funding liquidity, we find that securitizers need fewer core deposits to fund their balance sheets than non-securitizers.

To formally analyze our model’s theoretical prediction of the impact of securitization on solvency risk, profitability and leverage ratio, we constructed a method which enables us to predict the bank’s solvency risk, profitability and leverage ratio when hypothetically putting their securitized asset back on balance sheet. Comparing the predicted and observed values provides us with a quantitative estimate of securitization’s impact. When we placed classes of securitized assets back on balance sheet individually, we found that securitization generates lower loan loss provision ratios and solvency risk, and raises ROE and leverage ratios in most cases. When we placed all securitized assets back on balance sheets simultaneously, we still found that securitization benefits banks with a lower provision ratio. However, the other predictions of our model are rejected in most cases. We suspect that the inconsistency between putting the individual versus all securitized assets back on balance sheets is due to our empirical model specification or the construction of the variables that lead to small and large changes. We plan to explore this specification issue in our future research.

Appendix

A Tax Considerations

This part of the appendix is still under construction. In this section, we explicitly incorporate tax considerations into the analysis of section 3. Incorporating taxes requires substantial modification of the model, and of our simplifying assumptions:

A.1 The economy

The tax rate on corporate capital gains is denoted g , and the tax rate on corporate ordinary income is denoted τ .³⁶ For corporations, we assume that all expenses, including interest expense, and capital losses are tax deductible. For individual income, the tax rate on interest income is denoted τ_i and the tax-rate on distributions from corporations is τ_d .³⁷ In all cases, we assume that the given tax rates are the same as the tax-rates faced by the representative investor, and that these are the same marginal tax-rates that are faced by the bank.

Because interest income is taxed, the riskless rate r is implicitly defined by:

$$\frac{1}{1 + r(1 - \tau_i)} = \sum_f 1 \xi_f \pi_f,$$

and the price of claims with after-tax payoffs $X(f)$ at time 1, have time 0 prices $P(X)$ given by:

$$P(X) = E_q \left(\frac{X(f)}{1 + r(1 - \tau_i)} \right)$$

, where the Q-probabilities are the same as in section 3.2.

³⁶In the United States, the two are the same.

³⁷We follow the treatment in Hennessy and Whited (2005) and assume that corporate distributions whether through share repurchases or dividends are taxed at rate τ_D .

A.2 Lending Opportunities

Each entrepreneur needs to borrow S dollars for their project at time 0. The probabilities of default and the bank recovery upon default are as given in section 3.3. Each entrepreneur can pay back the bank at most ω dollars per dollar of face value if the loan is successful. We assume that the bank has monopoly power in originating and monitoring loans and contracts to receive ω when the loan is successful. If the loan is monitored, then the after-tax present value of the loan is V_m per dollar of face-value, where $V_m > 1$:

$$V_m = E_q \left[\frac{X - \tau_i(X - 1)}{1 + r(1 - \tau_i)} \right], \quad (\text{A1})$$

where $X = \omega$ if the loan is successful, and $X = \omega(1 - LGD)$ if it is unsuccessful.

To make monitoring incentive compatible for the bank, we assume that the bank expects to earn positive post-tax economic profits from making and monitoring each loan:

$$SV_m - (1 - \tau)K - S > 0$$

If the loan is not monitored, then its after-tax present value is V_n , with $V_n < 1$. This implies that the loans are only valuable when monitored.

A.3 A Single Loan

We first consider a bank that originates a single loan of S dollars. We consider the cases of opaque and non-opaque loans separately.

Transparent loan

We first consider a transparent loan that is partially financed by selling $S - \theta$ dollars of face value at price V_m , while holding θ dollars of face value on balance sheet. The remaining financing costs are covered by debt D and equity E . At time 1, when the loan matures, these transactions generate post corporate tax cashflows CF_1 for the bank:

$$CF_1 = [\theta X - D(1 + r_D)]^+ - (1 - \chi_D)\tau [\theta(X - 1) - Dr_D], \quad (\text{A2})$$

which can be decomposed into pre-corporate-tax loan cashflows net of debt repayments (term 1) less taxes levied on net corporate interest income (term 2).³⁸

At time 0, the bank's after-tax cashflows are:

$$\begin{aligned} CF_0 &= -S + (S - \theta)V_m - K(1 - \tau) - g(S - \theta)(V_m - 1) \\ &= FC(\theta, g) \end{aligned} \tag{A3}$$

where in the first equation, the first term is the amount of money for the loan, the second term is the revenues from selling $S - \theta$ dollars of loan face value at price V_m , the third term is the cost of monitoring the loan net of the tax deduction for the monitoring expense, and the last term subtracts off the tax on capital gains that the bank earned by selling off $(S - \theta)$ dollars of loan face value for a profit of $V_m - 1$ per dollar of loan face value. CF_0 is also the net financing cost of the single loan at time 0, denoted by $FC(\theta, g)$.

CF_0 is by assumption negative; and financed by issuing non-negative amounts of debt and or equity ($CF_0 = -[E + D]$). Therefore, the present value of equity holders cashflows net of taxes is given by:

$$V_E = (1 - \tau_D)E_q \left\{ \frac{CF_1}{1 + r(1 - \tau_i)} \right\} + (CF_0 + D) \tag{A4}$$

where the first term is the after-tax distribution to equity holders at time 1, and the second term on the right is the amount of equity contributed at time 0.

To gain intuition for how tax considerations affect the choices of D and θ , it is useful to consider two special cases.

Case 1 If the bank is financed by equity and loan sales, but not debt, and if $\tau_i = \tau$, then

$$V_E = S(V_m - 1)(1 - g) + \theta[(g - \tau_d)V_m - g] - K(1 - \tau)$$

In case 1, if the corporate tax rate on capital gains is less than or equal to the tax rate on distributions, then $\partial V_E / \partial \theta < 0$. Therefore, an all equity financed bank making a single transparent loan will choose the smallest θ that is consistent with the constraints that make monitoring incentive compatible.

³⁸We assume that taxes only get paid on corporate interest income if the bank is solvent ($\chi_D = 0$).

In case 1, whether the bank monitors or not, its cashflows at time 0 are identical. However, if the bank monitors, the present value of its cashflows at time 1 are given by θV_m . If instead the bank fails to monitor, and reinvests its savings from monitoring in the risk-free asset, then the present value of its time 1 cashflows are $\theta V_n + K$.³⁹ Rearrangement then shows that monitoring is incentive compatible if

$$\theta \geq \frac{K}{V_m - V_n} \quad (\text{A5})$$

Note: this incentive constraint has the same form as in the text [equation (7)], although because V_m and V_n are a function of tax rates, their meaning here differs slightly from the text.

Case 2: This is the same as case 1, except that the bank uses some debt financing, but that the amount is so small, that the probability of bank insolvency is zero. Under these circumstances, the spread on the bank's debt is zero, and V_E becomes:

$$V_E = S(V_m - 1)(1 - g) + \theta[(g - \tau_d)V_m - 1] - K(1 - \tau) + \tau_d D$$

In case 2, the last term captures the tax-shield effect of debt financing, and shows that equity holders prefer to finance with debt in the absence of costs due to bank insolvency. If there is no chance of bank insolvency, then the bank's optimal financing will involve choosing θ as small as possible subject to the incentive constraint (equation A5, and D as large as possible. In the main body of the text, equity holders also prefer to finance with debt and loan sales in the absence of insolvency costs, but the tax advantages of debt are modeled in a more simple fashion.

Opaque loan

Here we consider a single opaque loan that is solely financed by issuing equity. Here we only study separating equilibria in which the quantity of loans sold by the bank is an indication

³⁹In deriving this incentive constraint, we need to make assumptions on how the bank declares and pays its taxes when it chooses to shirk on monitoring. We assume that if the bank shirks from monitoring, the bank continues to treat K as a tax deductible expense in period 0 (although it is not), but the bank also properly pays tax on the interest from investing K riskfree instead of monitoring in period 1. There are of course alternative assumptions about how the bank declares and pays its taxes. These assumptions will generate different but qualitatively similar incentive constraints.

of loan quality. Following the treatment in section 3.4, in a fully separating equilibrium, the bank chooses q , the fraction of loan to sell, in order to maximize:

$$V_E(q) = \alpha + \Pi(q, V_m(\beta), \tau) \quad (\text{A6})$$

where,

$$\begin{aligned} \alpha &= (1 - \tau_D) S V_m(\beta) - S - K(1 - \tau) \\ \Pi(q, V_m(\beta), \tau) &= S q [(1 - g) P(q) + g - (1 - \tau_D) V_m(\beta)] \end{aligned}$$

Using the same equilibrium criteria as in section 3.4, it is straightforward to derive $q(\beta)$ and $P(q(\beta))$ in equilibrium⁴⁰:

$$q(\beta) = q^* \left(\frac{v_m(\beta) - \frac{g}{g - \tau_D}}{v_m(\beta_H) - \frac{g}{g - \tau_D}} \right)^{\frac{1-g}{g - \tau_D}} \quad (\text{A7})$$

$$p[q(\beta)] = \left[v_m(\beta_H) - \frac{g}{g - \tau_D} \right] \left(\frac{q(\beta)}{q^*} \right)^{\frac{g - \tau_D}{1-g}} + \frac{g}{g - \tau_D} \quad (\text{A8})$$

The expression for $q(\beta)$ shows that if the bottom of the support for $v_m(\beta)$ is equal to $\frac{g}{g - \tau_D}$, then $q(\beta) = 0$ for all β in the separating equilibrium, implying that in some circumstances adverse selection will make it impossible to sell loans. For simplicity, we assume throughout this appendix that opaque loans must be held on balance sheet.

A.4 Multiple Loans Financed with Debt, Equity, and Loan Sales

Here, we assume the bank finances N transparent loans, and N_O transparent loans. Applying equation (A3), its cashflows at time 0 are given by:

$$CF_0 = NFC(\theta, g) + N_O FC(S, g). \quad (\text{A9})$$

We assume these financing costs are met by issuing equity E , and debt that promises to pay D_1 if the bank is solvent, and net of bankruptcy costs and taxes, recovers the value of

⁴⁰To derive this answer, we guessed that $P(q) = Cq^\gamma + D$ and then solved for C , γ and D that are consistent with equilibrium.

the bank's assets when the bank is insolvent. D denotes the value of the debt at time 0. Given its capital structure, the bank's earnings at time 1 are

$$\pi(\theta, D_1) = [VP(\theta) - D_1] - \tau_i NI(\theta, D_1),$$

which is the value of the banks portfolio net of debt (term 1) and taxes on its net interest income, $NI(\theta, D_1)$:

$$NI(\theta, D_1) = \sum_{i=1}^N \theta (X_i - 1) + \sum_{j=1}^{N_O} S (X_j - 1) - (D_1 - D) \quad (\text{A10})$$

The bank's insolvency is defined by the indicator function χ_D where

$$\chi_D = \begin{cases} 1, & VP(\theta) < D_1 \\ 0, & VP(\theta) \geq D_1. \end{cases}$$

It is more natural to assume that insolvency is triggered when the banks cashflows are insufficient to jointly cover its debt and taxes. For computational purposes we have chosen a more stringent definition of insolvency that avoids the need to simultaneously value the debt and solve for when default is triggered.⁴¹

Equity holders receive $CF_1 = (1 - \tau_D)[\pi(\theta, D_1)]^+$ at time 1 after taxes if the bank is solvent at time 1. The present value of equity holders claims is given by:

$$V_E(\theta, D) = \frac{E_q CF_1}{1 + r(1 - \tau_i)} + (CF_0 - D)$$

where D is the value of debt-holders claims. D is the solution to:

$$D = \frac{E_q \{ (1 - \chi_D) [D_1 - \tau_i(D_1 - D)] + \chi_D [\phi VP(\theta) - \tau_i(\phi VP(\theta) - D)] \}}{1 + r(1 - \tau_i)}. \quad (\text{A11})$$

⁴¹At the threshold where insolvency is triggered using our definition, the bank is likely to receive a small tax rebate on its losses that it could use to service its debt obligations. In this sense, our trigger for default is a bit earlier than the natural trigger.

Rearrangement shows this simplifies to become:

$$D = \frac{E_q(1 - \chi_D)D_1 + \chi_D \phi VP(\theta)}{1 + r} \quad (\text{A12})$$

Note that in the above expression the tax rate drops out everywhere, but taxes do have an effect because taxes alter the equilibrium real interest rate r from what it would be in the absence of taxes.

B Financing with Debt, Equity, Loan Sales, and Securitization

When the hedge fund finances some of its loans through CLO securitization, we assume that the hedge fund sells θ_S dollars of face value of each loan that it securitizes to an SPV, and then buys back the first-loss piece to incentivize monitoring. The SPV is exempt from taxes, and has no bankruptcy costs. However, investors in the senior tranche of the SPV must pay taxes on their net interest income, investors that hold the first loss piece (the bank) must pay taxes on any distributions that they receive. In addition, the bank must pay capital gains taxes on its sales to the SPV.

The SPV's assets consist of N_s transparent loans that each have face value θ_S , as well as any additional credit enhancement CE that is contributed by the bank who is sponsoring the SPV. We assume the credit enhancement is invested riskfree, and will elaborate on its purpose here shortly. The SPV pays the bank $N_s \theta_s V_m$ for the loans. The SPV issues senior and junior securities whose payoffs before taxes are:

$$\tilde{H}_{sr} = \text{Max}[\omega \theta_s (N_s - \psi LGD), \sum_{j=1}^{N_s} \theta_s X_j] + CE(1 + r), \quad \text{and}$$

$$\tilde{H}_{jr} = \left[\sum_{j=1}^{N_s} \theta_s X_j - \tilde{H}_{sr} \right]^+$$

The senior tranche is valued like risky debt for tax purposes, and hence has after-tax value V_{sr} given by

$$V_{sr} = \frac{E_q \tilde{H}_{sr} - \tau_i(\tilde{H}_{sr} - V_{sr})}{1 + r(1 - \tau_i)} \quad (\text{A13})$$

$$= \frac{E_q \tilde{H}_{sr}}{1 + r} \quad (\text{A14})$$

The junior tranche is valued like a distribution to equity holders for tax purposes, and hence has value:

$$V_{jr} = E_q \frac{(1 - \tau_D) \tilde{H}_{jr}}{1 + r(1 - \tau)} \quad (\text{A15})$$

In the above formulation, the credit enhancement is chosen to ensure that the value of the SPV's securities to investors is sufficient to cover the SPV's costs of acquiring the assets from the SPV sponsor. It is also a theoretical possibility that the value of the SPV's securities, given its promised cashflow waterfall, exceed the SPV's cost of acquiring the assets. If this occurs, we assume that any cash surplus is immediately returned to investors in the equity tranche by reducing the amount that equity tranche investors pay to acquire the first loss piece.

The bank's residual financing costs at time 0, CF_0 when it securitizes N_s transparent assets in an SCLO are given by:

$$CF_0 = (N - N_s)FC(\theta, g) + N_O FC(S, g) + \{N_s FC(0, g) + VFLP + CE\} \quad (\text{A16})$$

The first two terms are the financing costs generated by the assets that are not securitized. The expression is securitizations' contribution to financing costs, and consists of three terms. Recall that we assume securitized loans are not held on balance sheet, but are instead securitized and/or sold in the loan sales market. These sales generate capital gains taxes $N_s FC(0, g)$, which is the first term. The second term is the cost of purchasing back the first-loss-piece of the securitization, while the last term is any additional credit enhancement that is required in the securitization.

Before taxes, the value of the bank's portfolio in the CLO securitization is:

$$VP(N_S, \theta, \theta_S, \psi)_{CLO} = \sum_{j=1}^{N_O} S X_j + \sum_{i=1}^{N-N_S} \theta X_{i+N_O} + \pi_{jr}(\theta_S, N_s, \psi) \quad (A17)$$

where

$$\pi_{jr}(\theta_S, N_s, \psi) = \left[CE(1+r) + \sum_{k=1}^{N_S} \theta_S X_{k+N_O+N-N_S} - \theta_S(N_S - \psi LGD) \right]^+, \quad (A18)$$

is the bank's before tax distribution from the equity tranche of the CLO.

The bank's earnings at time 1 after taxes are:

$$\pi(\theta, \theta_S, \psi, N_s) = VP(N_S, \theta, \theta_S, \psi)_{CLO} - D_1 - \tau_I NI(\theta, \theta_S, N_s) - \tau_D \pi_{jr}(\theta_S, N_s, \psi)$$

where the second term is the tax on net interest income, and net interest income is:

$$NI(\theta, \theta_S, N_s) = \sum_{j=1}^{N_O} S (X_j - 1) + \sum_{i=1}^{N-N_S} \theta (X_{i+N_O} - 1) - (D_1 - D),$$

and the third term is the tax on the distribution from the equity tranche of the CLO.

We assume the bank's profits after taxes are distributed to equity holders at time 1. Therefore, the present value of the bank's cashflows to equity holders is given by:

$$VE_{CLO} = \frac{E_q(1 - \tau_D)[\pi(\theta, \theta_S, \psi, N_s)]^+}{1 + r(1 - \tau_i)} + (CF_0 - D) \quad (A19)$$

Finally, the event that the bank defaults on its debt is denoted by the indicator function $\chi_{D,CLO}$. Default occurs if

$$VP(N_S, \theta, \theta_S, \psi)_{CLO} - \tau_D \pi_{jr}(\theta_S, N_s, \psi) \leq D_1$$

. We chose this default threshold because it allows us to partially incorporate the banks ability to pay its taxes in the determination of its default trigger, while still allowing us not to have to account for how taxes on its debt affect likelihood and the value of the debt.

If default occurs, the holders of the banks debt recover:

$$r(\theta, \theta_S, \psi, N_s) = \phi[\pi(\theta, \theta_S, \psi, N_s) + D_1 + \tau_I(D_1 - D)]^+,$$

which is the value of the bank's assets after it has paid taxes on its interest income and any distributions to the equity tranche of the CLO.⁴²

We assume the debt holders recovery is taxed as interest income. Based on these assumptions, the value of the bank's debt is

$$D = \frac{E_q[(1 - \chi_{D,CLO})D_1 + (\chi_{D,CLO}) r(\theta, \theta_S, \psi, N_s)]}{1 + r} \quad (\text{A20})$$

⁴²The bank does not get to dededuct its interest payments to debt holders in this case since it defaulted on its debt.

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Table 1: Number and Percent of BHCs that Sell and Securitize Assets by Type

	Securitizers of all types assets		Mortgage Sellers/Securitizers				HEL Sellers/Securitizers				C&I Sellers/Securitizers				Credit Card Sellers/Securitizers				Other Sellers/Securitizers			
Quarters	N	% of BHCs	N		% of BHCs		N		% of BHCs		N		% of BHCs		N		% of BHCs		N		% of BHCs	
Q2:2001	5	0.27	83	79	6.20	4.27	0	12	0.00	0.65	12	19	0.90	1.03	7	14	0.50	0.76	8	32	0.60	1.73
Q3:2001	3	0.16	107	82	7.50	4.36	0	12	0.00	0.64	13	19	0.90	1.01	10	14	0.70	0.75	7	36	0.50	1.92
Q4:2001	3	0.16	129	80	8.70	4.25	0	12	0.00	0.64	23	19	1.60	1.01	12	14	0.80	0.74	7	35	0.50	1.86
Q1:2002	3	0.16	147	66	9.60	3.43	0	11	0.00	0.57	25	17	1.60	0.88	13	14	0.90	0.73	8	34	0.50	1.77
Q2:2002	2	0.10	157	76	10.40	3.90	0	13	0.00	0.67	28	19	1.90	0.97	14	12	0.90	0.62	8	33	0.50	1.69
Q3:2002	4	0.20	168	77	10.70	3.87	0	13	0.00	0.65	29	21	1.90	1.06	17	12	1.10	0.60	8	34	0.50	1.71
Q4:2002	3	0.15	171	76	10.30	3.76	0	13	0.00	0.64	28	21	1.70	1.04	17	11	1.00	0.54	10	34	0.60	1.68
Q1:2003	3	0.14	194	77	11.10	3.71	0	12	0.00	0.58	29	16	1.70	0.77	17	10	1.00	0.48	10	30	0.60	1.45
Q2:2003	3	0.14	207	79	11.00	3.76	0	12	0.00	0.57	29	14	1.50	0.67	20	10	1.10	0.48	11	29	0.60	1.38
Q3:2003	3	0.14	217	80	11.20	3.71	0	14	0.00	0.65	29	16	1.50	0.74	21	10	1.10	0.46	9	28	0.50	1.30
Q4:2003	3	0.14	226	77	11.40	3.54	0	14	0.00	0.64	25	13	1.30	0.60	20	9	1.00	0.41	8	27	0.40	1.24
Q1:2004	3	0.13	239	66	11.70	2.96	0	16	0.00	0.72	22	11	1.10	0.49	21	10	1.00	0.45	6	26	0.30	1.17
Q2:2004	3	0.13	253	66	12.20	2.94	0	16	0.00	0.71	22	10	1.10	0.44	22	10	1.10	0.44	6	27	0.30	1.20
Q3:2004	3	0.13	273	69	12.80	3.03	0	16	0.00	0.70	23	10	1.10	0.44	20	10	0.90	0.44	6	26	0.30	1.14
Q4:2004	3	0.13	281	73	13.00	3.18	1	15	0.00	0.65	25	12	1.20	0.52	20	12	0.90	0.52	4	27	0.20	1.18
Q1:2005	3	0.13	290	73	13.10	3.15	2	17	0.10	0.73	22	12	1.00	0.52	19	14	0.90	0.60	4	30	0.20	1.29
Q2:2005	3	0.13	301	77	13.40	3.30	3	16	0.10	0.69	20	12	0.90	0.51	17	14	0.80	0.60	5	31	0.20	1.33
Q3:2005	4	0.17	302	78	13.40	3.35	3	18	0.10	0.77	21	13	0.90	0.56	18	15	0.80	0.64	5	31	0.20	1.33
Q4:2005	4	0.17	312	82	13.90	3.56	4	19	0.20	0.82	22	11	1.00	0.48	20	17	0.90	0.74	6	32	0.30	1.39
Q1:2006	2	0.20	181	49	18.40	4.88	5	14	0.50	1.39	15	10	1.50	1.00	13	17	1.30	1.69	4	21	0.40	2.09
Q2:2006	2	0.20	187	50	19.00	5.03	4	13	0.40	1.31	15	10	1.50	1.01	14	15	1.40	1.51	3	20	0.30	2.01
Q3:2006	2	0.20	193	52	19.50	5.26	3	13	0.30	1.31	18	10	1.80	1.01	14	15	1.40	1.52	3	20	0.30	2.02

Note: N is the total number of loan sellers or asset securitizers in a given quarter. The column “% of BHCs” is the percentage of bank holding companies that sold or securitized the reported asset class in a given quarter. The asset classes are mortgages, home equity lines of credit (HEL), Commercial and Industrial Loans (C & I), Credit Card loans, and Other.

Table 2: Assets and Loans of Sellers / Securitizers as a Percentage of all U.S. BHC Assets

Quarter	Securitizers of all types assets	Mortgage		HEL		C&I		Credit Card		Other	
		Sellers	Securitizers	Sellers	Securitizers	Sellers	Securitizers	Sellers	Securitizers	Sellers	Securitizers
Q2:2001	27.00%	38.10%	76.30%		53.00%	18.30%	42.40%	40.50%	59.30%	7.90%	72.30%
Q3:2001	11.10%	43.80%	77.10%		54.30%	17.60%	30.60%	45.70%	56.00%	6.50%	73.50%
Q4:2001	11.10%	48.20%	76.50%		53.20%	19.80%	30.60%	45.70%	54.90%	6.80%	72.30%
Q1:2002	11.10%	72.00%	72.50%		52.30%	44.30%	30.40%	45.80%	55.00%	7.00%	73.10%
Q2:2002	8.90%	70.70%	74.10%		53.10%	42.90%	31.50%	47.20%	51.20%	6.70%	71.80%
Q3:2002	41.40%	70.30%	73.60%		52.50%	42.30%	64.70%	45.30%	50.10%	7.00%	71.30%
Q4:2002	42.00%	73.40%	74.00%		53.20%	34.80%	65.20%	46.80%	50.40%	7.50%	71.80%
Q1:2003	42.50%	76.60%	74.20%		53.50%	35.30%	54.00%	47.80%	50.30%	7.80%	70.60%
Q2:2003	42.50%	76.20%	74.80%		53.80%	36.40%	51.90%	47.90%	50.80%	9.00%	70.50%
Q3:2003	41.70%	76.90%	73.70%		54.60%	34.30%	52.60%	46.80%	49.50%	6.90%	69.30%
Q4:2003	42.00%	76.50%	73.90%		53.20%	10.20%	52.70%	47.60%	49.40%	6.40%	68.70%
Q1:2004	40.60%	79.90%	75.50%		55.10%	4.40%	50.70%	46.40%	52.10%	0.90%	71.20%
Q2:2004	40.70%	79.00%	76.60%		55.20%	28.20%	50.20%	48.00%	52.50%	0.90%	72.60%
Q3:2004	40.20%	79.60%	76.90%		54.70%	12.60%	49.60%	46.00%	52.20%	0.90%	72.30%
Q4:2004	39.60%	77.90%	76.30%	0.00%	53.90%	12.10%	49.40%	46.10%	54.40%	0.10%	71.60%
Q1:2005	37.70%	78.70%	76.50%	1.40%	61.60%	12.00%	49.60%	42.40%	54.50%	0.10%	73.50%
Q2:2005	37.90%	76.30%	76.50%	1.40%	57.00%	12.00%	49.50%	42.60%	54.50%	0.10%	73.40%
Q3:2005	31.80%	69.50%	74.50%	1.60%	52.70%	13.00%	44.60%	28.60%	50.10%	0.10%	70.80%
Q4:2005	31.90%	69.50%	74.70%	8.10%	52.50%	13.00%	41.80%	28.20%	50.10%	0.10%	70.80%
Q1:2006	28.20%	75.60%	69.60%	8.90%	41.50%	17.00%	40.00%	31.50%	47.00%	0.20%	66.80%
Q2:2006	27.70%	74.10%	67.80%	2.10%	39.30%	16.70%	39.20%	29.20%	46.10%	0.20%	65.30%
Q3:2006	28.90%	75.90%	69.60%	16.70%	40.80%	19.40%	40.80%	30.90%	47.60%	0.20%	67.00%

Notes: The table presents the assets and loans of all U.S. Bank Holding Companies (BHCs) that sell and securitize assets as a fraction of the loans and assets of all U.S. BHCs.

Table 5: Sold and Securitized Loans as a Percentage of on Balance Sheet Loans by Type

	Mortgage		HEL		C&I		Credit Card		Other	
Quarter	Sold	Securitized	Sold	Securitized	Sold	Securitized	Sold	Securitized	Sold	Securitized
Q2:2001	3.50%	143.70%	0.00%	31.50%	0.50%	6.40%	0.10%	125.30%	0.30%	9.30%
Q3:2001	3.90%	155.30%	0.00%	29.20%	0.50%	6.70%	0.10%	138.30%	0.20%	9.00%
Q4:2001	5.20%	161.90%	0.00%	30.30%	0.60%	6.90%	0.10%	135.40%	0.20%	8.60%
Q1:2002	5.50%	154.80%	0.00%	28.30%	0.60%	6.20%	0.10%	129.00%	0.10%	8.50%
Q2:2002	4.90%	162.20%	0.00%	32.30%	0.60%	9.40%	0.10%	133.40%	0.10%	8.20%
Q3:2002	3.80%	158.20%	0.00%	36.20%	0.50%	5.20%	0.00%	124.40%	0.10%	7.50%
Q4:2002	5.10%	150.10%	0.00%	30.60%	0.50%	5.20%	0.00%	123.40%	0.10%	7.40%
Q1:2003	5.30%	87.20%	0.00%	13.60%	0.50%	4.20%	0.20%	135.60%	0.10%	6.90%
Q2:2003	4.60%	80.20%	0.00%	12.90%	0.50%	4.50%	0.20%	136.50%	0.10%	6.50%
Q3:2003	4.60%	74.40%	0.00%	12.00%	0.50%	4.40%	0.20%	131.00%	0.10%	6.40%
Q4:2003	4.90%	93.30%	0.00%	19.80%	0.50%	4.90%	0.10%	98.90%	0.10%	6.20%
Q1:2004	9.80%	66.30%	0.00%	11.40%	0.50%	4.10%	0.10%	102.70%	0.00%	8.90%
Q2:2004	8.70%	66.00%	0.00%	11.30%	0.70%	4.50%	0.20%	99.10%	0.00%	7.90%
Q3:2004	4.10%	90.10%	0.00%	10.30%	0.50%	4.80%	0.20%	91.10%	0.00%	7.80%
Q4:2004	3.70%	81.30%	0.00%	10.10%	0.50%	4.40%	0.10%	89.20%	0.00%	7.80%
Q1:2005	4.40%	75.00%	0.00%	10.20%	0.50%	4.80%	0.10%	94.70%	0.00%	7.50%
Q2:2005	3.00%	78.20%	0.00%	11.20%	0.50%	4.50%	0.10%	93.40%	0.00%	8.20%
Q3:2005	3.10%	64.50%	0.00%	11.30%	0.50%	5.40%	0.10%	86.20%	0.00%	8.40%
Q4:2005	3.20%	66.70%	0.00%	10.60%	0.60%	6.00%	0.10%	81.30%	0.00%	11.10%
Q1:2006	4.60%	68.20%	0.20%	21.20%	0.60%	8.80%	0.00%	110.20%	0.00%	11.00%
Q2:2006	4.30%	71.20%	0.00%	16.00%	0.60%	9.90%	0.00%	107.90%	0.00%	11.60%
Q3:2006	4.40%	74.20%	0.00%	18.20%	0.60%	7.00%	0.00%	109.70%	0.00%	11.50%

Notes: The table presents sold and securitized loans as a percentage of on balance sheet loans for all US Bank Holding companies (BHCs) in a given quarter.

Table 6: Equity Holders' Expected Profit when Financing with Debt, Equity, and Loan Sales

θ	α										
	0.03	0.05	0.07	0.09	0.11	0.13	0.15	0.17	0.19	0.21	0.23
36.98	18.40	20.11	25.53	28.94	31.24	32.76	32.14	31.13	29.85	28.55	27.24
41.98	14.98	16.92	23.08	26.95	29.57	31.30	30.59	29.38	27.98	26.50	25.02
46.98	11.55	13.73	17.62	24.96	27.90	29.83	29.04	27.68	26.12	24.46	22.79
51.98	8.13	10.54	14.85	22.97	26.22	27.47	27.49	25.98	24.25	22.41	20.57
56.98	3.46	7.35	12.08	20.99	24.55	25.91	25.93	24.28	22.38	20.37	18.34
61.98	-0.07	4.16	9.30	19.00	22.87	24.36	24.38	22.58	20.50	18.32	16.12
<i>66.98</i>	<i>-3.61</i>	<i>0.97</i>	<i>6.53</i>	<i>13.01</i>	<i>21.20</i>	<i>22.80</i>	22.83	<i>20.89</i>	<i>18.63</i>	<i>16.28</i>	<i>13.89</i>
71.98	-7.14	-2.23	3.76	10.72	19.53	21.25	21.27	19.19	16.76	14.23	11.67
76.98	-10.67	-5.42	0.98	8.43	17.85	19.69	19.72	17.49	14.89	12.18	9.44
81.98	-14.21	-8.61	-1.79	6.15	16.18	18.14	17.59	15.79	13.02	10.14	7.22
86.98	-17.74	-11.80	-4.57	3.86	14.50	16.59	16.00	14.09	11.15	8.09	4.99
91.98	-21.27	-18.88	-7.34	1.57	12.83	15.03	14.41	12.39	9.28	6.05	2.77
96.98	-24.81	-22.28	-10.11	-0.72	11.16	<u>13.48</u>	12.82	10.69	7.42	4.00	0.54

Note: For the two period economy presented in section 4.1 when all loans are transparent, the table presents the expected present value of equity holders net cashflows (expected profit) as a function of the percentage of the face value of each transparent loan held by the bank (θ) and as a function of the fraction of the banks financing needs that are met by equity holders (α). In the table, equity is taxed at a rate of 2 percent, and 97% of the value of the bank's assets are recovered if the bank becomes insolvent. To provide an incentive for the bank to monitor its loans, the bank must hold more than 66.98 percent of each asset's face value on its balance sheet. The set of α and θ for which this incentive constraint is binding are highlighted in italics. Faced with this constraint, the banks profit from making optimal financing and loan sale choices is highlighted in bold face. The bank's profit when it cannot sell any loans, corresponding to $\theta = 100$, is approximated by its maximal profit when $\theta = 96.98$, and is highlighted in bold-face type and underlined.

Table 7: Simulations for 2-Period Model with Transparent Loans

A. No Securitization	30 loans					90 loans				
ϕ	0.95	0.96	0.97	0.98	0.99	0.95	0.96	0.97	0.98	0.99
θ	66.98	66.98	66.98	66.98	66.98	66.98	66.98	66.98	66.98	66.98
α	14.89%	14.89%	14.89%	12.37%	0.00%	14.05%	14.05%	13.21%	12.37%	10.70%
N_S	-	-	-	-	-	-	-	-	-	-
ψ	-	-	-	-	-	-	-	-	-	-
θ_S	-	-	-	-	-	-	-	-	-	-
Minimum θ_S	-	-	-	-	-	-	-	-	-	-
Default Prob. (state 1)	0.00%	0.00%	0.00%	0.00%	0.29%	0.00%	0.00%	0.00%	0.00%	0.00%
Default Prob. (state 2)	0.00%	0.00%	0.00%	0.00%	1.19%	0.00%	0.00%	0.00%	0.00%	0.00%
Default Prob. (state 3)	8.06%	8.06%	8.06%	16.11%	90.16%	2.82%	2.82%	4.76%	7.69%	17.47%
Unconditional Default Prob.	0.08%	0.08%	0.08%	0.16%	1.27%	0.03%	0.03%	0.05%	0.08%	0.17%
Expected Profit	6.18	6.51	6.84	7.43	8.76	22.76	23.12	23.71	24.53	26.15
SCLO Protection Cost	-	-	-	-	-	-	-	-	-	-
Value of CLO Equity Tranche	-	-	-	-	-	-	-	-	-	-
Value of CLO Sr. Tranche	-	-	-	-	-	-	-	-	-	-
Spread of CLO Sr. Tranche	-	-	-	-	-	-	-	-	-	-
Debt Value	1689.47	1689.80	1690.13	1737.72	1943.08	5125.99	5126.35	5175.34	5224.21	5320.19
Debt Spread	0.20%	0.18%	0.16%	0.30%	2.33%	0.05%	0.04%	0.06%	0.08%	0.16%
Total Financing Costs	2024.63	2024.63	2024.63	2024.63	2024.63	6073.88	6073.88	6073.88	6073.88	6073.88

Table 7: Simulations for 2-Period Model with Transparent Loans (Continued)

B. SCLO	30 loans					90 loans				
ϕ	0.95	0.96	0.97	0.98	0.99	0.95	0.96	0.97	0.98	0.99
θ	—	—	—	—	—	—	—	—	—	—
α	0.25%	0.25%	0.25%	0.25%	0.25%	0.00%	0.00%	0.00%	0.00%	0.00%
N_S	30	30	30	30	30	90	90	90	90	90
ψ	2	2	2	2	2	5	5	5	5	5
θ_S	91.32821	91.32821	91.32821	91.32821	91.32821	91.23972	91.23972	91.23972	91.23972	91.23972
Minimum θ_S	91.04	91.04	91.04	91.04	91.04	91.03	91.03	91.03	91.03	91.03
Default Prob. (state 1)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Default Prob. (state 2)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Default Prob. (state 3)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Unconditional Default Prob.	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Expected Profit	13.35	13.35	13.35	13.35	13.35	40.47	40.47	40.47	40.47	40.47
SCLO Protection Cost	76.07	76.07	76.07	76.07	76.07	241.25	241.25	241.25	241.25	241.25
Value of CLO Equity Tranche	-	-	-	-	-	-	-	-	-	-
Value of CLO Sr. Tranche	-	-	-	-	-	-	-	-	-	-
Spread of CLO Sr. Tranche	-	-	-	-	-	-	-	-	-	-
Debt Value	2785.02	2785.02	2785.02	2785.02	2785.02	8380.71	8380.71	8380.71	8380.71	8380.71
Debt Spread	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Total Financing Costs	2842.03	2842.03	2842.03	2842.03	2842.03	8531.05	8531.05	8531.05	8531.05	8531.05

Table 7: Simulations for 2-Period Model with Transparent Loans (Continued)

C. CLO	30 loans					90 loans				
ϕ	0.95	0.96	0.97	0.98	0.99	0.95	0.96	0.97	0.98	0.99
θ	—	—	—	—	—	—	—	—	—	—
α	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
N_S	30	30	30	30	30	90	90	90	90	90
ψ	1	1	1	1	1	3	3	3	3	3
θ_S	66.98049	66.98049	66.98049	66.98049	66.98049	66.98049	66.98049	66.98049	66.98049	66.98049
Minimum θ_S	66.98	66.98	66.98	66.98	66.98	66.98	66.98	66.98	66.98	66.98
Default Prob. (state 1)	45.45%	45.45%	45.45%	45.45%	45.45%	26.88%	26.88%	26.88%	26.88%	26.88%
Default Prob. (state 2)	59.90%	59.90%	59.90%	59.90%	59.90%	50.90%	50.90%	50.90%	50.90%	50.90%
Default Prob. (state 3)	99.92%	99.92%	99.92%	99.92%	99.92%	100.00%	100.00%	100.00%	100.00%	100.00%
Unconditional Default Prob.	47.30%	47.30%	47.30%	47.30%	47.30%	29.78%	29.78%	29.78%	29.78%	29.78%
Expected Profit	14.43	14.43	14.43	14.43	14.43	43.44	43.44	43.44	43.44	43.44
SCLO Protection Cost	-	-	-	-	-	-	-	-	-	-
Value of CLO Equity Tranche	19.83	19.83	19.83	19.83	19.83	48.46	48.46	48.46	48.46	48.46
Value of CLO Sr. Tranche	2019.59	2019.59	2019.59	2019.59	2019.59	6069.79	6069.79	6069.79	6069.79	6069.79
Spread of CLO Sr. Tranche	3.56%	3.56%	3.56%	3.56%	3.56%	3.38%	3.38%	3.38%	3.38%	3.38%
Debt Value	1.96	1.96	1.96	1.96	1.96	2.12	2.12	2.12	2.12	2.12
Debt Spread	92.50%	92.50%	92.50%	92.50%	92.50%	63.91%	63.91%	63.91%	63.91%	63.91%
Total Financing Costs	5.04	5.04	5.04	5.04	5.04	4.09	4.09	4.09	4.09	4.09

Notes: For the two-period economy in section 4.1, when the bank's loan portfolio consists of 30 or 90 transparent loans, the table presents results on bank performance when securitization is not possible (panel A), and when it can occur through an SCLO (panel B) or a CLO (panel C). ϕ is the percentage of the bank's assets that is recovered in insolvency. The face value of loan is 100, and θ and θ_S are the percentages of each loan's face value that is held on balance sheet, or securitized. Net of securitization and loan sales, approximately α and $1 - \alpha$ percent of the bank's remaining Total Financing Costs are covered by debt and equity (see footnote 17). N_S is the number of securitized loans. ψ is the number of defaults absorbed by the equity tranche in a CLO, or absorbed by the bank with an SCLO. Minimum θ_S is the smallest θ_S for which monitoring the securitized assets is incentive compatible. The bank's insolvency probabilities in state i , and unconditionally are denoted Default Prob (state i), and Unconditional Default Prob. Expected Profit is the expected present value of equity holders net cashflows. SCLO Protection Cost is the price of purchasing credit protection using an SCLO. The table also provides the present value of the cashflows of the senior (Sr.) and equity tranche of the CLO, as well as the senior tranche's spread, the value of the bank's debt, and its spread, and the total financing costs that are covered by debt and equity holders.

Table 8: Simulations for 2-Period Model with Opaque and Transparent Loans

A. No Securitization					
ϕ	0.95	0.96	0.97	0.98	0.99
θ	66.98	66.98	66.98	66.98	66.98
α	14.74%	14.74%	13.21%	13.21%	11.68%
N_S	-	-	-	-	-
ψ	-	-	-	-	-
θ_S	-	-	-	-	-
Minimum θ_S	-	-	-	-	-
Default Prob. (state 1)	0.00%	0.00%	0.00%	0.00%	0.00%
Default Prob. (state 2)	0.00%	0.00%	0.00%	0.00%	0.00%
Default Prob. (state 3)	2.61%	2.61%	6.61%	6.61%	14.54%
Unconditional Default Prob.	0.03%	0.03%	0.07%	0.07%	0.15%
Expected Profit	15.01	15.45	16.20	17.33	19.43
SCLO Protection Cost	-	-	-	-	-
Value of CLO Equity Tranche	-	-	-	-	-
Value of CLO Sr. Tranche	-	-	-	-	-
Spread of CLO Sr. Tranche	-	-	-	-	-
Debt Value	6768.74	6769.18	6887.33	6888.46	7006.15
Debt Spread	0.04%	0.04%	0.08%	0.07%	0.11%
Total Financing Costs	8084.63	8084.63	8084.63	8084.63	8084.63
B. SCLO					
ϕ	0.95	0.96	0.97	0.98	0.99
θ	66.98	66.98	66.98	66.98	66.98
α	11.22%	10.43%	10.43%	8.72%	7.14%
N_S	30	30	30	28	30
ψ	2	2	2	1	1
θ_S	90.82	91.31065	91.31065	99.09	100
Minimum θ_S	90.65	90.27	90.27	99.08	98.41
Default Prob. (state 1)	0.00%	0.00%	0.00%	0.00%	0.00%
Default Prob. (state 2)	0.00%	0.00%	0.00%	0.00%	0.00%
Default Prob. (state 3)	1.80%	3.50%	3.50%	8.47%	17.75%
Unconditional Default Prob.	0.02%	0.04%	0.04%	0.09%	0.18%
Expected Profit	19.01	19.34	20.03	21.18	23.47
SCLO Protection Cost	75.64	76.05	76.05	99.46	109.39
Value of CLO Equity Tranche	-	-	-	-	-
Value of CLO Sr. Tranche	-	-	-	-	-
Spread of CLO Sr. Tranche	-	-	-	-	-
Debt Value	7747.72	7828.71	7829.39	8150.46	8380.60
Debt Spread	0.03%	0.05%	0.04%	0.08%	0.13%
Total Financing Costs	8886.13	8901.48	8901.48	9096.58	9199.39

Table 8: Simulations for 2-Period Model with Opaque and Transparent Loans (Continued)

C. CLO					
ϕ	0.95	0.96	0.97	0.98	0.99
θ	66.98	66.98	66.98	66.98	66.98
α	16.55%	15.28%	14.32%	12.24%	0.10%
N_S	30	27	28	30	30
ψ	3	2	2	2	2
θ_S	90.27	99	99.125	98.5	78.26531
Minimum θ_S	90.27	98.97	99.08	98.41	77.26
Default Prob. (state 1)	0.00%	0.00%	0.00%	0.00%	0.02%
Default Prob. (state 2)	0.00%	0.00%	0.00%	0.00%	0.30%
Default Prob. (state 3)	3.50%	5.49%	8.43%	17.75%	99.23%
Unconditional Default Prob.	0.04%	0.06%	0.08%	0.18%	1.04%
Expected Profit	19.06	19.35	20.31	21.84	24.73
SCLO Protection Cost	-	-	-	-	-
Value of CLO Equity Tranche	120.12	80.55	79.57	76.97	61.16
Value of CLO Sr. Tranche	2628.42	2632.36	2737.37	2922.15	2321.85
Spread of CLO Sr. Tranche	2.16%	2.64%	2.68%	2.77%	2.77%
Debt Value	5051.15	5263.34	5263.34	5265.63	5843.23
Debt Spread	0.07%	0.09%	0.12%	0.24%	2.53%
Total Financing Costs	6165.33	6329.70	6260.74	6122.18	6106.37

Notes: When the bank has 60 opaque loans that can be neither sold nor securitized and 30 transparent loans that can be sold or securitized, the table presents simulation results on the bank's risk, profitability, and capital structure when it cannot securitize (panel A), when it can securitize via a Collateralized Loan Obligation (panel B) and when it can securitize via a Synthetic Collateralized Loan Obligation (panel C). The variable definitions for the table are explained in Table 7.

Table 9: Simulations: Multi-Period Model with Transparent Loans

A. No Securitization					
ϕ	0.95	0.96	0.97	0.98	0.99
θ	66.98	66.98	66.98	66.98	66.98
α	14.9%	14.1%	14.1%	13.2%	13.2%
N_S	-	-	-	-	-
ψ	-	-	-	-	-
θ_S	-	-	-	-	-
Minimum θ_S	-	-	-	-	-
Default Prob. (State 1)	0.00%	0.00%	0.00%	0.00%	0.00%
Default Prob. (State 2)	0.00%	0.00%	0.00%	0.00%	0.00%
Default Prob. (State 3)	1.59%	2.82%	2.82%	4.76%	4.76%
Unconditional Default Prob.	0.02%	0.03%	0.03%	0.05%	0.05%
Per-Period Expected Profit	22.56	23.12	23.48	24.31	24.93
Franchise Value	2231.85	2259.99	2295.09	2333.00	2391.74
SCLO Protection Cost	-	-	-	-	-
Value of CLO Equity Tranche	-	-	-	-	-
Value of CLO Sr. Tranche	-	-	-	-	-
Spread of CLO Sr. Tranche	-	-	-	-	-
Debt Value	5077.12	5126.13	5126.49	5175.54	5176.15
Debt Spread	0.03%	0.04%	0.04%	0.05%	0.04%
Total Financing Costs	6073.88	6073.88	6073.88	6073.88	6073.88
B. SCLO					
ϕ	0.95	0.96	0.97	0.98	0.99
θ	66.98	66.98	66.98	66.98	66.98
α	0.00%	0.00%	0.00%	0.00%	0.00%
N_S	90	90	90	90	90
ψ	5	5	5	5	5
θ_S	91.10	91.10	91.10	91.10	91.10
Minimum θ_S	91.03	91.03	91.03	91.03	91.03
Default Prob. (State 1)	0.00%	0.00%	0.00%	0.00%	0.00%
Default Prob. (State 2)	0.00%	0.00%	0.00%	0.00%	0.00%
Default Prob. (State 3)	0.00%	0.00%	0.00%	0.00%	0.00%
Unconditional Default Prob.	0.00%	0.00%	0.00%	0.00%	0.00%
Per-Period Expected Profit	40.48	40.48	40.48	40.48	40.48
Franchise Value	4068.09	4068.09	4068.09	4068.09	4068.09
SCLO Protection Cost	240.88	240.88	240.88	240.88	240.88
Value of CLO Equity Tranche	-	-	-	-	-
Value of CLO Sr. Tranche	-	-	-	-	-
Spread of CLO Sr. Tranche	-	-	-	-	-
Debt Value	8367.81	8367.81	8367.81	8367.81	8367.81
Debt Spread	0.00%	0.00%	0.00%	0.00%	0.00%
Total Financing Costs	8517.92	8517.92	8517.92	8517.92	8517.92

Table 9: Simulations for Multi-Period Model with Transparent Loans (Continued)

C. CLO						
ϕ	0.95	0.96	0.97	0.98	0.99	
θ	66.98	66.98	66.98	66.98	66.98	
α	100%	100%	100%	100%	100%	
N_S	90	90	90	90	90	
ψ	5	5	5	5	5	
θ_S	94.00	94.00	94.00	94.00	94.00	
Minimum θ_S	93.96	93.96	93.96	93.96	93.96	
Default Prob. (State 1)	0.00%	0.00%	0.00%	0.00%	0.00%	
Default Prob. (State 2)	0.00%	0.00%	0.00%	0.00%	0.00%	
Default Prob. (State 3)	0.00%	0.00%	0.00%	0.00%	0.00%	
Unconditional Default Prob.	0.00%	0.00%	0.00%	0.00%	0.00%	
Per-Period Expected Profit	41.09	41.09	41.09	41.09	41.09	
Franchise Value	4129.61	4129.61	4129.61	4129.61	4129.61	
SCLO Protection Cost	-	-	-	-	-	
Value of CLO Equity Tranche	163.87	163.87	163.87	163.87	163.87	
Value of CLO Sr. Tranche	8422.44	8422.44	8422.44	8422.44	8422.44	
Spread of CLO Sr. Tranche	2.91%	2.91%	2.91%	2.91%	2.91%	
Debt Value	0	0	0	0	0	
Debt Spread	
Total Financing Costs	119.5005	119.5005	119.5005	119.5005	119.5005	

Notes: For the multiperiod model in section 6.2, when all loans are transparent, the table provides information on the bank's performance, including its discounted expected profits (Franchise Value) and the bank's profits during each time period (Per-Period Expected Profit). For a description of the other variables, see Table 7.

Table 10: Simulations for Multi-Period Model with Opaque and Transparent Loans

A. No Securitization					
ϕ	0.95	0.96	0.97	0.98	0.99
θ	66.98	66.98	66.98	66.98	66.98
α	14.7%	14.4%	14.1%	13.2%	12.9%
N_S	-	-	-	-	-
ψ	-	-	-	-	-
θ_S	-	-	-	-	-
Minimum θ_S	-	-	-	-	-
Default Prob. (State 1)	0.00%	0.00%	0.00%	0.00%	0.00%
Default Prob. (State 2)	0.00%	0.00%	0.00%	0.00%	0.00%
Default Prob. (State 3)	2.61%	3.15%	3.82%	6.61%	7.83%
Unconditional Default Prob.	0.03%	0.03%	0.04%	0.07%	0.08%
Per-Period Expected Profit	15.01	15.55	16.21	17.39	18.79
Franchise Value	1470.07	1515.48	1569.53	1640.22	1751.56
SCLO Protection Cost	-	-	-	-	-
Value of CLO Equity Tranche	-	-	-	-	-
Value of CLO Sr. Tranche	-	-	-	-	-
Spread of CLO Sr. Tranche	-	-	-	-	-
Debt Value	6768.70	6792.64	6816.66	6891.49	6916.00
Debt Spread	0.04%	0.05%	0.05%	0.07%	0.06%
Total Financing Costs	8084.63	8084.63	8084.63	8084.63	8084.63
B. SCLO					
ϕ	0.95	0.96	0.97	0.98	0.99
θ	66.98	66.98	66.98	66.98	66.98
α	11.2%	11.2%	10.4%	10.4%	9.6%
N_S	30	30	30	30	30
ψ	2	2	2	2	2
θ_S	93.00	93.00	91.00	91.00	90.00
Minimum θ_S	90.65	90.65	90.27	90.27	89.62
Default Prob. (State 1)	0.00%	0.00%	0.00%	0.00%	0.00%
Default Prob. (State 2)	0.00%	0.00%	0.00%	0.00%	0.00%
Default Prob. (State 3)	1.80%	1.80%	3.52%	3.52%	6.44%
Unconditional Default Prob.	0.018%	0.018%	0.035%	0.035%	0.064%
Per-Period Expected Profit	18.93	19.28	20.15	20.84	22.37
Franchise Value	1869.15	1903.73	1956.58	2023.18	2112.82
SCLO Protection Cost	77.46	77.46	75.79	75.79	74.96
Value of CLO Equity Tranche	-	-	-	-	-
Value of CLO Sr. Tranche	-	-	-	-	-
Spread of CLO Sr. Tranche	-	-	-	-	-
Debt Value	7812.65	7813.00	7826.04	7826.72	7866.85
Debt Spread	0.03%	0.03%	0.04%	0.03%	0.05%
Total Financing Costs	8954.32	8954.32	8891.76	8891.76	8860.48

Table 10: Simulations for Multi-Period Model with Opaque and Transparent Loans
(Continued)

C. CLO					
ϕ	0.95	0.96	0.97	0.98	0.99
θ	66.98	66.98	66.98	66.98	70.73
α	16.6%	16.6%	16.6%	15.3%	14.3%
N_S	30	30	30	30	28
ψ	3	3	3	3	2
θ_S	91.00	91.00	91.00	90.00	100.00
Minimum θ_S	90.27	90.27	90.27	89.62	99.08
Default Prob. (State 1)	0.00%	0.00%	0.00%	0.00%	0.00%
Default Prob. (State 2)	0.00%	0.00%	0.00%	0.00%	0.00%
Default Prob. (State 3)	3.50%	3.50%	3.50%	6.42%	8.43%
Unconditional Default Prob.	0.035%	0.035%	0.035%	0.064%	0.084%
Per-Period Expected Profit	19.01	19.45	19.89	21.08	22.54
Franchise Value	1846.37	1888.79	1931.20	1991.75	2090.20
SCLO Protection Cost	-	-	-	-	-
Value of CLO Equity Tranche	121.09	121.09	121.09	119.76	80.27
Value of CLO Sr. Tranche	2649.67	2649.67	2649.67	2620.55	2761.53
Spread of CLO Sr. Tranche	2.16%	2.16%	2.16%	2.16%	2.68%
Debt Value	5049.90	5050.34	5050.77	5124.67	5275.94
Debt Spread	0.07%	0.06%	0.05%	0.08%	0.08%
Total Financing Costs	6166.30	6166.30	6166.30	6164.97	6269.06

Notes: For the multiperiod model in section 6.2, when the bank has 60 opaque loans that can be neither sold nor securitized and 30 transparent loans that can be sold or securitized, the table presents simulation results on the banks risk, profitability, and capital structure when it cannot securitize (panel A), when it can securitize via a Synthetic Collateralized Loan Obligation (panel B) and when it can securitize via a Collateralized Loan Obligation (panel C). For a description of the other variables, see Tables 9 and 7.

Table 11: Comparison of Securitizers and Non-Securitizers

	Securitizers			Non-Securitizers				
Mortgage	N	Mean	Std	N	Mean	Std	p-values	% difference of means
ln(Assets)	2145	12.9119	1.0038	147	15.0426	2.4653	< .0001	15.2%
Loans/Assets	2145	0.6678	0.1294	147	0.6404	0.1297	0.0131	-4.2%
Mortgage/Loans	2145	0.2429	0.1578	147	0.2711	0.1422	0.0345	11.0%
Provision ratio	2145	0.0022	0.0047	147	0.0025	0.0022	0.3783	14.4%
Nonaccrual+Charge-off/Loans	2145	0.0085	0.0112	147	0.0110	0.0104	0.0085	25.8%
Time deposit premium	2144	0.0268	0.0366	147	0.0243	0.0384	0.4189	-9.9%
ROE	2145	0.1063	0.0569	147	0.1141	0.0475	0.1094	7.1%
Leverage ratio	2145	0.9045	0.0365	147	0.9075	0.0220	0.3303	0.3%
Loans/Deposits	2145	0.8445	0.3067	147	0.9667	0.4479	< .0001	12.2%
HEL								
ln(Assets)	2278	12.9936	1.1370	24	18.0930	2.1894	< .0001	32.8%
Loans/Assets	2278	0.6659	0.1300	24	0.5905	0.1774	0.0049	-12.0%
HEL/Loans	2278	0.0354	0.0395	24	0.0850	0.0511	< .0001	82.4%
Provision ratio	2278	0.0022	0.0045	24	0.0043	0.0032	0.0249	64.2%
Nonaccrual and Chargeoff/Loans	2278	0.0085	0.0111	24	0.0174	0.0186	0.0001	68.4%
Time deposit premium	2267	0.0269	0.0366	24	0.0017	0.0440	0.0008	-176.2%
ROE	2278	0.1066	0.0560	24	0.1300	0.0782	0.0423	19.8%
Leverage ratio	2278	0.9046	0.0360	24	0.9116	0.0202	0.3429	0.8%
Loans/Deposits	2278	0.8514	0.3264	24	1.2828	0.9505	< .0001	43.1%
C&I								
ln(Assets)	2270	12.9961	1.1427	32	16.6408	3.0573	< .0001	24.6%
Loans/Assets	2270	0.6657	0.1302	32	0.6288	0.1662	0.1134	-5.7%
C&I/Loans	2270	0.1596	0.0967	32	0.2355	0.0930	< .0001	38.4%
Provision ratio	2270	0.0022	0.0045	32	0.0038	0.0028	0.0539	52.2%
Nonaccrual+Charge-off/Loans	2270	0.0086	0.0111	32	0.0137	0.0136	0.0104	46.0%
Time deposit premium	2259	0.0269	0.0367	32	0.0053	0.0322	0.0009	-134.1%
ROE	2270	0.1067	0.0562	32	0.1154	0.0660	0.3822	7.9%
Leverage ratio	2270	0.9047	0.0360	32	0.9064	0.0236	0.7915	0.2%
Loans/Deposits	2270	0.8541	0.3419	32	0.9822	0.2592	0.0349	12.8%

Table 11: Comparison of Securitizers and Non-Securitizers (Continued)

	Securitizers			Non-Securitizers			p-values	% difference of means
Credit	N	Mean	Std	N	Mean	Std		
ln(Assets)	2268	12.9976	1.1524	34	16.3248	2.9662	< .0001	22.7%
Loans/Assets	2268	0.6656	0.1308	34	0.6359	0.1255	0.1892	-4.6%
Credit/Loans	2268	0.0032	0.0233	34	0.0798	0.1469	< .0001	184.5%
Provision ratio	2268	0.0021	0.0036	34	0.0092	0.0226	< .0001	125.2%
Nonaccrual+Charge-off/Loans	2268	0.0085	0.0108	34	0.0179	0.0249	< .0001	71.3%
Time deposit premium	2257	0.0268	0.0367	34	0.0177	0.0392	0.1557	-40.5%
ROE	2268	0.1067	0.0536	34	0.1146	0.1541	0.4139	7.2%
Leverage ratio	2268	0.9048	0.0356	34	0.8981	0.0491	0.2776	-0.7%
Loans/Deposits	2268	0.8500	0.2906	34	1.2475	1.4674	< .0001	37.9%
Other								
ln(Assets)	2254	12.9528	1.0546	48	17.4575	2.1255	< .0001	29.6%
Loans/Assets	2254	0.6663	0.1298	48	0.6096	0.1622	0.0029	-8.9%
Other/Loans	2254	0.0733	0.0745	48	0.1381	0.0906	< .0001	61.3%
Provision ratio	2254	0.0022	0.0045	48	0.0046	0.0041	0.0002	72.4%
Nonaccrual+Charge-off/Loans	2254	0.0085	0.0112	48	0.0129	0.0097	0.008	40.5%
Time deposit premium	2243	0.0268	0.0367	48	0.0185	0.0375	0.1203	-36.8%
ROE	2254	0.1062	0.0557	48	0.1360	0.0764	0.0003	24.6%
Leverage ratio	2254	0.9051	0.0339	48	0.8865	0.0871	0.0004	-2.1%
Loans/Deposits	2254	0.85197	0.34072	48	1.0398	0.3132	0.0002	19.9%
	Ever-Securitizers			Never-Securitizers				
ln(Assets)	2113	12.7872	0.8851	188	14.9462	2.3139	< .0001	15.6%
Loans/Assets	2113	0.6634	0.1266	188	0.6413	0.1250	0.0214	-3.4%
Mortgage/Loans	2113	0.2515	0.1596	188	0.2607	0.1442	0.4452	3.6%
HEL/Loans	2113	0.0324	0.0379	188	0.0458	0.0362	< .0001	34.4%
C&I/Loans	2113	0.1630	0.0987	188	0.1767	0.0880	0.0676	8.0%
Credit/Loans	2113	0.0031	0.0239	188	0.0189	0.0685	< .0001	143.8%
Other/Loans	2113	0.0742	0.0755	188	0.0922	0.0761	0.0018	21.6%
Provision ratio	2113	0.0021	0.0039	188	0.0034	0.0082	0.0001	47.3%
Nonaccrual+Charge-off/Loans	2113	0.0080	0.0094	188	0.0112	0.0122	< .0001	34.0%
Time deposit premium	2103	0.0332	0.0385	188	0.0357	0.0379	0.3898	7.3%
ROE	2113	0.1054	0.0498	188	0.1124	0.0769	0.079	6.5%
Leverage ratio	2113	0.9059	0.0334	188	0.9037	0.0481	0.4066	-0.2%
Loans/Deposits	2113	0.8339	0.2697	188	0.9904	0.7289	< .0001	17.2%

Notes: This table compares the characteristics of securitizers and non-securitizers. All variables in column "Mean" ("Std") are the cross sectional mean (Standard deviation) of the individual BHC time series average. Ln(Assets) is the natural logarithm of assets in thousand of U.S. dollars. Provision ratio is the total provision divided by total loans. Nonaccrual +Charge-off is the sum of nonaccrual and charge off loans over total loans. Rate on deposit is the interest expense on deposit divided by total deposit. Time deposit premium is the spread between the rate on large (above US\$100,000) and small (below US\$100,000) time deposits. ROE is the income before tax and extraordinary item and other adjustments divided by average equity. Leverage ratio is the total liabilities over assets. Column "p-values" report statistical difference between the means of securitizers and non-securitizers. % difference of means is the difference of securitizers' and non-securitizers' mean over 0.5 times the sum of securitizers' and non-securitizers' mean.

Table 12: Regression Analysis

	Model (1)		Model (2)		Model (3)		Model (4)		Model (5)	
Provision ratio	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat
Mortgage/Loans	-0.0012	-4.18	-0.0007	-2.04	-0.0007	-2.1	-0.0005	-1.52	-0.0001	-0.21
HEL/Loans	-0.0018	-0.77	-0.0024	-1.05	-0.0023	-1.01	-0.0022	-0.97	-0.0024	-1.06
C&I/Loans	0.0010	1.15	0.0015	1.75	0.0015	1.67	0.0014	1.63	0.0014	1.57
Credit/Loans	0.0988	5.79	0.0984	6	0.0986	6.01	0.0993	6.03	0.0996	6.06
Other/Loans	0.0018	1.80	0.0027	2.91	0.0027	2.93	0.0031	3.14	0.0032	3.22
30-89 days pastdue//Loans	0.0040	0.45	0.0041	0.46	0.0036	0.4	0.0067	0.79	0.0061	0.72
90 days+ pastdue/Loans	0.0186	0.77	0.0237	1.01	0.0239	1.01	0.0259	1.11	0.0322	1.36
Nonaccrual+Charge-off/Loans	0.1567	10.02	0.1570	10.15	0.1564	10.09	0.1518	10.12	0.1517	10.08
Loans/Assets	-0.0001	-2.93	0.0031	5.71	0.0031	5.72	0.0034	6.48	0.0033	6.31
Rate on Deposit					0.0052	3.24				
Small Time Depo. Rate							0.0060	1.57		
Large Time Depo. Rate									-0.0089	-5.81
Ln(Assets)	-0.0001	-2.93	-0.0001	-2.04	-0.0001	-2.1	-0.0001	-2.06	-0.0001	-1.57
Constant	0.0023	3.77	-0.0007	-0.89	-0.0007	-0.89	-0.0009	-1.31	-0.0008	-1.13
Obs/Adj-R-Square	2113	78.26%	2113	79.16%	2113	79.2%	2106	79.47%	21033	79.76%

	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat
Time deposit premium										
Mortgage/Loans	0.0863	15.26	0.0850	14.4	0.0849	14.39	0.0414	11.59	0.0006	0.29
HEL/Loans	0.0083	0.39	0.0094	0.45	0.0096	0.46	-0.0253	-1.9	0.0199	2.99
C&I/Loans	-0.0476	-4.71	-0.0488	-4.76	-0.0489	-4.75	0.0049	0.85	-0.0194	-4.07
Credit/Loans	-0.0175	-0.48	-0.0168	-0.45	-0.0165	-0.44	0.0119	0.65	-0.0132	-0.95
Other/Loans	0.0482	3.78	0.0461	3.57	0.0461	3.57	0.0085	1.25	0.0095	2.48
30-89 days past due//Loans	-0.0824	-0.58	-0.0843	-0.59	-0.0852	-0.59	-0.0615	-0.77	0.0135	0.31
90 days+ pastdue/Loans	0.9871	3.12	0.9754	3.07	0.9756	3.07	0.6207	3.6	-0.0893	-1.04
Nonaccrual+Charge-off/Loans	0.0171	0.14	0.0179	0.15	0.0169	0.14	0.0295	0.43	-0.0150	-0.42
Loans/Assets			-0.0071	-1.03	-0.0071	-1.03	-0.0051	-1.22	0.0010	0.4
Rate on Deposit					0.0082	0.18				
Small Time Depo. Rate							-2.0059	-30.33		
Large Time Depo. Rate									1.3342	101.58
Ln(Assets)	-0.0020	-1.84	-0.0021	-1.93	-0.0021	-1.94	0.0038	6.62	-0.0032	-6.79
Constant	0.0395	2.8	0.0462	3.08	0.0462	3.08	0.0082	1	0.0099	1.58
Obs/Adj-R-square	2103	20.21%	2103	20.22%	2103	20.18%	2103	73.48%	2103	91.2%

Table 12: Regression Analysis (Continued)

	Model (1)		Model (2)		Model (3)		Model (4)		Model (5)	
ROE	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat
Mortgage/Loans	-0.0780	-9.06	-0.0631	-7.44	-0.0627	-7.41	-0.0604	-6.92	-0.0483	-5.69
HEL/Loans	-0.1244	-4.13	-0.1409	-4.62	-0.1432	-4.68	-0.1414	-4.59	-0.1448	-4.67
C&I/Loans	-0.0864	-5.35	-0.0733	-4.45	-0.0720	-4.39	-0.0735	-4.44	-0.0761	-4.6
Credit/Loans	0.0811	2.16	0.0769	3.13	0.0768	3.09	0.0777	3.2	0.0833	3.42
Other/Loans	-0.0397	-3.01	-0.0139	-1.01	-0.0138	-1.01	-0.0194	-1.53	-0.0141	-1.07
Loans/Assets			0.0829	7.65	0.0828	7.64	0.0846	7.95	0.0832	7.96
Rate on Deposit					-0.0889	-1.1				
Small Time Depo. Rate							0.0605	0.7		
Large Time Depo. Rate									-0.2123	-4.55
Ln(Assets)	0.0040	2.96	0.0051	3.91	0.0051	3.94	0.0048	3.61	0.0051	3.97
Constant	0.0943	5.36	0.0183	0.98	0.0186	1	0.0193	1.04	0.0248	1.34
Obs/Adj-R-square	2113	6.78%	2113	10.47%	2113	10.78%	2106	10.88%	2103	11.93%

	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat
Leverage ratio										
Mortgage/Loans	-0.0228	-2.5	-0.0091	-1.17	-0.0091	-1.16	-0.0070	-0.89	-0.0050	-0.59
HEL/Loans	0.0435	1.56	0.0284	1.31	0.0282	1.3	0.0313	1.41	0.0290	1.33
C&I/Loans	-0.0009	-0.06	0.0111	0.75	0.0112	0.75	0.0068	0.45	0.0089	0.61
Credit/Loans	-0.1271	-4.08	-0.1309	-4.96	-0.1310	-4.97	-0.1321	-5.06	-0.1314	-5.03
Other/Loans	-0.0363	-2.93	-0.0128	-1.12	-0.0128	-1.12	-0.0045	-0.41	-0.0044	-0.42
Loans/Assets			0.0757	6.92	0.0757	6.91	0.0762	6.92	0.0763	6.83
Rate on Deposit					-0.0079	-0.41				
Small Time Depo. Rate							0.1268	2.61		
Large Time Depo. Rate									-0.0692	-2.25
Ln(Assets)	0.0004	0.55	0.0014	1.76	0.0014	1.77	0.0011	1.41	0.0015	1.89
Constant	0.9079	84.45	0.8385	60.25	0.8385	60.1	0.8395	61.08	0.8388	58.39
Obs/Adj-R-square	2113	2.74%	2113	10.12%	2113	10.08%	2106	10.24%	2103	10.29%

Notes: This table reports OLS regression results for bank holding companies that never securitize assets. The variables Provision ratio, Rate on Deposit, Time deposit premium, ROE, Leverage ratio, and Ln(Assets) are defined in Table 11. 30-89 days past due/Loans, 90 days + pastdue/Loans, and Nonaccrual +Charge-off/Loans are the loan quality measures. Small (large) time deposit rate is the interest rate on time deposits of less (more) than US \$100,000 dollars.

Table 13: Summary statistics of securitizers' actual and hypothetical balance sheet information

Variable	Mort			HEL			C&I		
	Mean	Std. Dev.	% Δ	Mean	Std. Dev.	% Δ	Mean	Std. Dev.	% Δ
Mortgage/Loans	0.2711	0.1422		0.2779	0.1782		0.1845	0.1017	
A-Mortgage/A-Loans	0.3167	0.1707	16.8%	0.2626	0.1440	-5.5%	0.1812	0.1027	0.9%
HEL/Loans	0.0525	0.0426		0.0850	0.0511		0.0610	0.0357	
A-HEL/A-Loans	0.0483	0.0391	-7.9%	0.1112	0.0789	30.8%	0.0601	0.0352	-1.4%
C&I/Loans	0.1642	0.0760		0.1941	0.0845		0.2355	0.0930	
A-C&I/A-Loans	0.1540	0.0730	-6.2%	0.1912	0.0832	-1.5%	0.2548	0.1095	17.8%
Credit/Loans	0.0127	0.0378		0.0341	0.0516		0.0298	0.0639	
A-Credit/A-Loans	0.0117	0.0366	-7.3%	0.0340	0.0515	-0.2%	0.0293	0.0623	-2.5%
Other/Loans	0.0870	0.0726		0.0856	0.0481		0.0926	0.0754	
A-Other/A-Loans	0.0821	0.0711	-5.6%	0.0848	0.0481	-1.0%	0.0907	0.0739	-2.0%
30-89 days pastdue/Loans	0.0108	0.0075		0.0114	0.0094		0.0092115	0.0045	
A-30-89 days pastdue/A-Loans	0.0116	0.0081	7.3%	0.0111	0.0074	-2.9%	0.0096569	0.0048	7.0%
90 days + pastdue/Loans	0.0022	0.0027		0.0034	0.0037		0.0023575	0.0019	
A-90 days + pastdue/A-Loans	0.0027	0.0038	21.0%	0.0035	0.0029	2.8%	0.0025498	0.0018	-2.1%
Nonaccrual+Charge-off/Loans	0.0110	0.0104		0.0174	0.0186		0.0136542	0.0136	
A-Nonaccrual+Charge-off/A-Loans	0.0094	0.0076	-14.4%	0.0160	0.0144	-8.2%	0.0144383	0.0125	-8.6%
Loans/Assets	0.6404	0.1297		0.5905	0.1774		0.6288004	0.1662	
A-Loans/A-Assets	0.6602	0.1244	3.1%	0.5968	0.1721	1.1%	0.6336312	0.1616	0.8%
Ln(Assets)	15.0426	2.4653		18.0931	2.1894		16.6408	3.0573	
Ln(A-Assets)	15.1023	2.5030	0.4%	18.1065	2.1859	0.1%	16.6540	3.0513	-0.2%
Obs	147			24			32		

Table 13: Summary statistics of securitizers' actual and hypothetical balance sheet information (continued)

Variable	Credit			Other			All		
	Mean	Std. Dev.	% Δ	Mean	Std. Dev.	% Δ	Mean	Std. Dev.	% Δ
Mortgage/Loans	0.2341	0.1290		0.2269	0.1181		0.2607	0.1442	
A-Mortgage/A-Loans	0.2264	0.1279	-3.3%	0.2227	0.1149	-1.9%	0.2795	0.1705	7.2%
HEL/Loans	0.0423	0.0341		0.0692	0.0462		0.0458	0.0362	
A-HEL/A-Loans	0.0406	0.0335	-4.0%	0.0672	0.0458	-2.9%	0.0494	0.0406	7.9%
C&I/Loans	0.1724	0.0853		0.1967	0.0822		0.1767	0.0880	
A-C&I/A-Loans	0.1657	0.0849	-3.8%	0.1926	0.0842	-2.1%	0.1649	0.0894	-6.7%
Credit/Loans	0.0798	0.1469		0.0435	0.0996		0.0189	0.0685	
A-Credit/A-Loans	0.1130	0.1835	41.5%	0.0418	0.0967	-3.9%	0.0233	0.0852	23.4%
Other/Loans	0.1036	0.0820		0.1380	0.0906		0.0922	0.0761	
A-Other/A-Loans	0.0951	0.0658	-8.2%	0.1586	0.1192	14.9%	0.0914	0.0864	-0.9%
30-89 days pastdue/Loans	0.0140	0.0165		0.0110	0.0053		0.0117	0.0085	
A-30-89 days pastdue/A-Loans	0.0141	0.0165	1.2%	0.0119	0.0056	8.0%	0.0147	0.0077	26.2%
90 days + pastdue/Loans	0.0038	0.0060		0.0030	0.0022		0.0026	0.0037	
A-90 days + pastdue/A-Loans	0.0041	0.0060	6.9%	0.0033	0.0022	8.7%	0.0064	0.0033	147.0%
Nonaccrual+Charge-off/Loans	0.0179	0.0249		0.0129	0.0097		0.0112	0.0122	
A-Nonaccrual+Charge-off/A-Loans	0.0189	0.0260	5.5%	0.0136	0.0094	6.0%	0.0139	0.0082	24.1%
Loans/Assets	0.6359	0.1255		0.6096	0.1622		0.6413	0.1250	
A-Loans/A-Assets	0.6462	0.1252	1.6%	0.6143	0.1592	0.8%	0.6611	0.1261	3.1%
Ln(Assets)	16.3248	2.9662		17.4576	2.1255		14.9462	2.3139	
Ln(A-Assets)	16.3569	2.9846	0.2%	17.4708	2.1200	0.1%	15.1337	2.3673	1.3%
Obs	34			48			188		

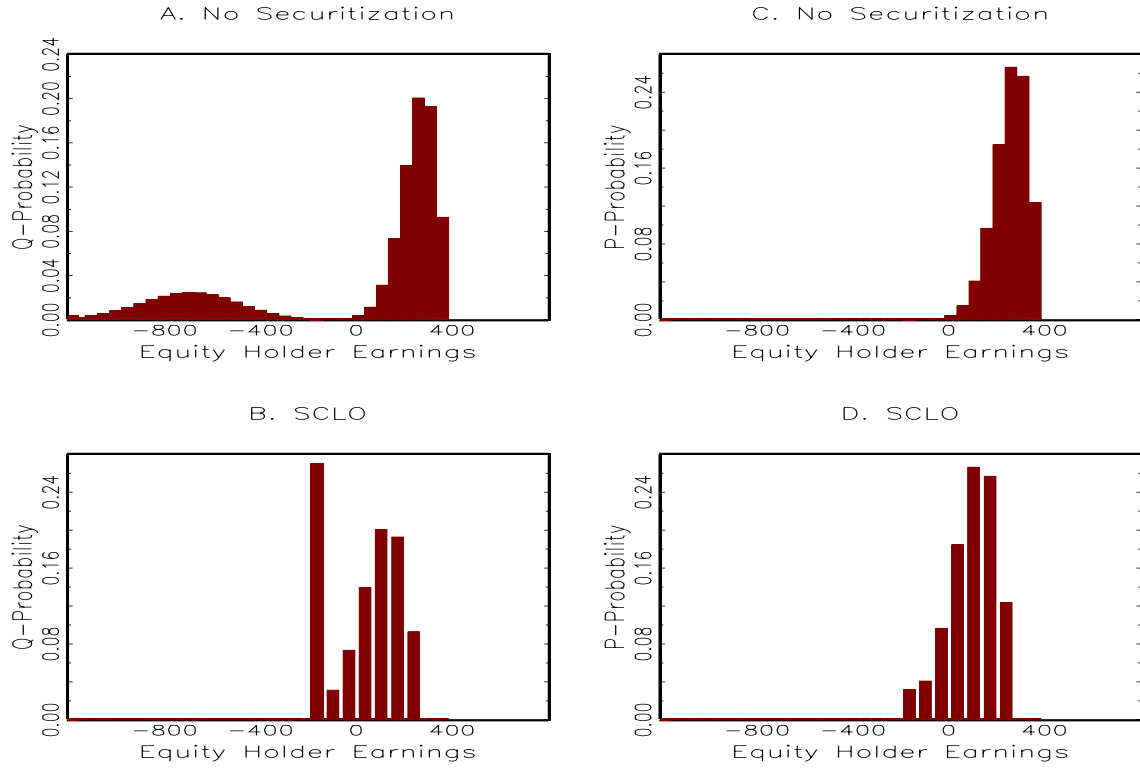
Notes: This table reports securitizers balance sheet summary statistics and hypothetical statistics (labelled with an A- prefix) that are constructed by moving their securitized assets back on balance sheet. All variables in column "Mean" ("Std") are the cross sectional mean (Standard deviation) of the individual BHC time series averages. Mortgage/Loans are on balance mortgages divided by on balance sheet loans. HEL/Loans, C&I/Loans, Credit/Loans, Other/Loans and their corresponding hypothetical values are defined similarly. % Δ is the percentage change between the hypothetical and observed values. Columns "Mort, HEL, C&I, Credit, and Other" present results when those securitized asset classes are individually added to the balance sheet. Column "All" is based on putting all types of securitized assets back on BHC balance sheets.

Table 14: The predicted and observed measures of solvency risk, ROE and leverage ratio

Provision ratio	Mort	HEL	C&I	Credit	Other	All
Predicted Value-Model (1)	0.30%	0.55%	0.49%	1.24%	0.67%	0.48%
Predicted Value-Model (2)	0.32%	0.54%	0.49%	1.24%	0.67%	0.49%
Predicted Value-Model (3)	0.31%	0.54%	0.49%	1.25%	0.67%	0.49%
Predicted Value-Model (4)	0.29%	0.51%	0.49%	1.25%	0.67%	0.49%
Predicted Value-Model (5)	0.32%	0.58%	0.50%	1.25%	0.67%	0.50%
Mean of securitizers' Provision ratio	0.25%	0.43%	0.38%	0.92%	0.46%	0.34%
Time deposit premium						
Predicted Value-Model (1)	2.86%	1.48%	0.68%	<i>1.58%</i>	<i>0.96%</i>	<i>3.54%</i>
Predicted Value-Model (2)	2.88%	1.49%	0.67%	<i>1.57%</i>	<i>0.94%</i>	<i>3.51%</i>
Predicted Value-Model (3)	2.83%	1.49%	0.67%	<i>1.57%</i>	<i>0.94%</i>	<i>3.55%</i>
Predicted Value-Model (4)	2.93%	0.68%	1.15%	2.33%	1.99%	4.30%
Predicted Value-Model (5)	<i>2.21%</i>	0.27%	<i>0.20%</i>	<i>1.31%</i>	<i>1.40%</i>	<i>3.06%</i>
Mean of securitizers' Time depo. Premium	2.43%	0.17%	0.53%	1.77%	1.85%	3.57%
ROE						
Predicted Value-Model (1)	11.05%	12.42%	<i>12.26%</i>	<i>13.32%</i>	12.17%	11.13%
Predicted Value-Model (2)	11.40%	12.25%	<i>12.32%</i>	<i>13.51%</i>	12.37%	<i>11.42%</i>
Predicted Value-Model (3)	11.41%	12.25%	<i>12.33%</i>	<i>13.51%</i>	12.38%	9.56%
Predicted Value-Model (4)	11.40%	12.27%	<i>12.34%</i>	<i>13.54%</i>	12.40%	<i>11.36%</i>
Predicted Value-Model (5)	<i>11.52%</i>	12.47%	<i>12.43%</i>	<i>13.54%</i>	12.29%	<i>11.39%</i>
Mean of securitizers' ROE	11.41%	13.00%	11.54%	11.46%	13.60%	11.24%
Leverage ratio						
Predicted Value-Model (1)	89.89%	89.89%	90.05%	88.27%	<i>89.62%</i>	<i>90.38%</i>
Predicted Value-Model (2)	90.19%	89.74%	90.11%	88.44%	<i>89.78%</i>	<i>90.64%</i>
Predicted Value-Model (3)	90.23%	89.74%	90.11%	88.44%	<i>89.78%</i>	<i>90.64%</i>
Predicted Value-Model (4)	90.22%	89.80%	90.15%	88.36%	<i>89.77%</i>	<i>90.61%</i>
Predicted Value-Model (5)	90.24%	89.85%	90.16%	88.46%	<i>89.82%</i>	<i>90.67%</i>
Mean of securitizers' Leverage Ratio	90.75%	91.16%	90.64%	89.81%	88.65%	90.37%

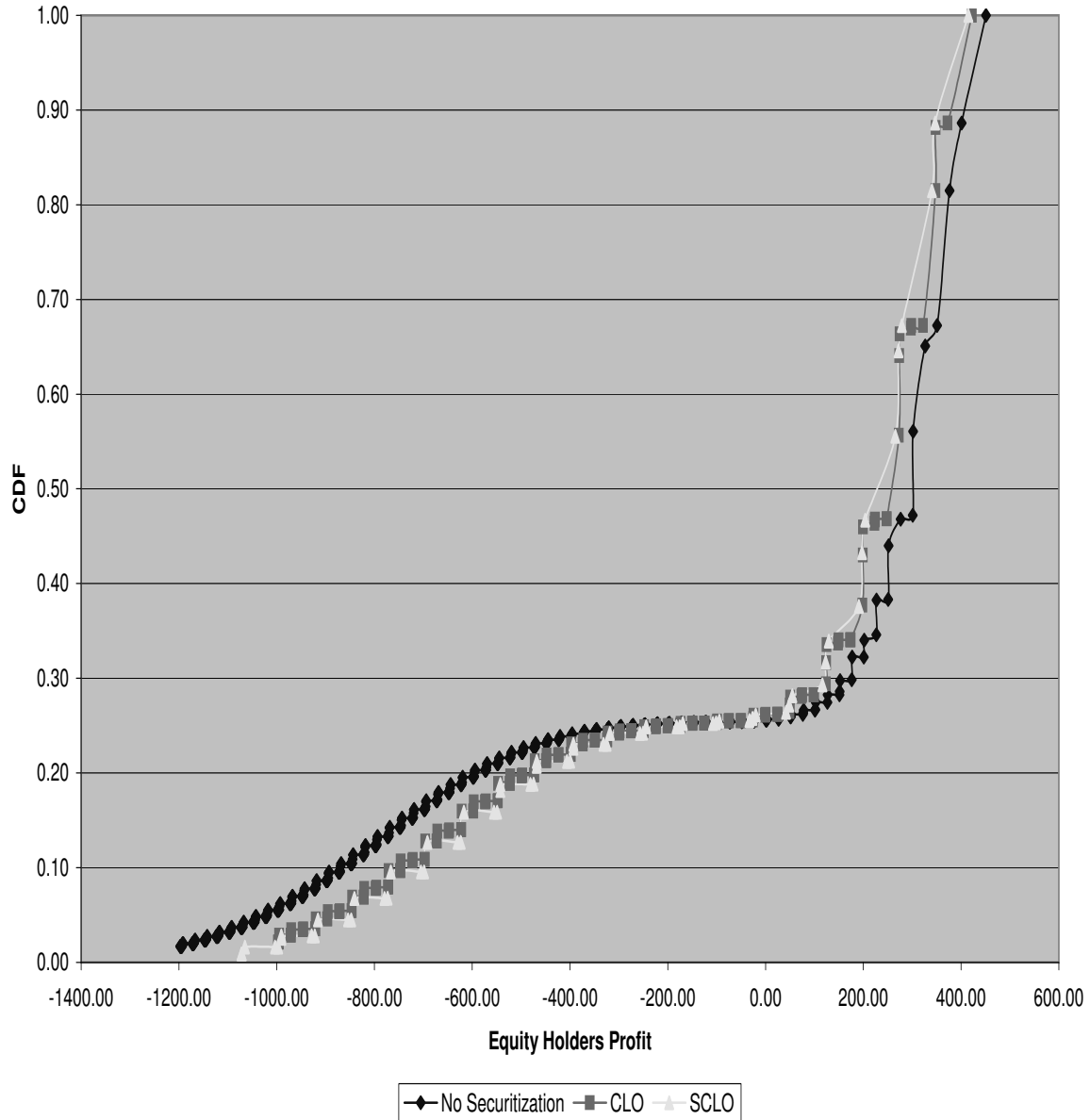
Notes: This table reports predicted values for securitizers' loan loss provision, time deposit premium, ROE, and leverage if their securitized assets were moved back on balance sheet. These figures are contrasted with securitizers actual values for these variables, which are provided in bold-face. The predicted values are calculated by moving securitized assets back on balance sheet to create hypothetical balance sheet variables (labeled with "A-" in Table 13). Predictions are then generated by applying the balance sheet variables to the regressions in Table 12. Values in italics indicate inconsistency with our theoretical model. Results are presented when each asset class is moved back on balance sheet individually (Columns Mort, HEL, C&I, Credit, and Other) and when all securitized assets are returned to the balance sheet (All).

Figure 1: **Distribution of Share Holder Earnings: $\Phi = 0.95$**



Notes: For an example similar to Table 7 when 95% of the banks assets can be recovered in insolvency, the figure presents the distribution of share holder earnings net of taxes and initial equity holders' outlays when the bank can or cannot choose to securitize via a synthetic collateralized loan obligation (SCLO). The distributions under the Q-measure with and without securitization are presented in panels A and B. The distributions under the P-measure are presented in panels C and D.

Figure 2: **Distribution of Share Holders Profits Under Q: Opaque and Transparent Loans**



Notes: For the example in Table 8 when 97% of the banks assets can be recovered in insolvency, the figure presents the Cumulative Distribution Function (CDF) of the present value of the equity holders profits from investing in the bank under the Q-measure when it does not securitize any assets (dark diamonds) and when it securitizes its transparent loans with a CLO (gray boxes) or an SCLO (light triangles).